HEWLETT PACKARD

OPERATING AND SERVICE MANUAL

MODEL 4261A
DIGITAL LCR METER

(Including Options 001, 002 and 003)

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 1821J.

With changes described in Section Ⅶ, this manual also applies to instruments with serial numbers prefixed 1545J, 1622J, and 1810J.

For additional important information about serial numbers, see INSTRUMENTS COVERED BY MANUAL in Section Ⅰ.

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9-1, TAKAKURA-CHO, HACHIOJI-SHI, TOKYO, JAPAN

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SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This Operating and Service Manual contains the information required to install, operate, test, adjust and service the Hewlett-Packard Model 4261A Digital LCR Meter. Figure 1-1 shows the instrument and accessories supplied. This section covers specifications, instrument identification, description, options, accessories, and other basic information.

1-3. Listed on the title page of this manual is a Microfiche part number. This number can be used to order 4 x 6 inch microfilm transparencies of the manual. Each microfiche contains up to 60 photoduplicates of the manual pages. The microfiche package also includes the latest Manual Changes supplement as well as all pertinent Service Notes. To order an additional manual use the part number listed on the title page of this manual.

1-4. SPECIFICATIONS.

1-5. Complete specifications of the Model 4261A LCR Meter are given in Table 1-1. These specifications are the performance standards or limits against which the instrument is tested. The test procedures for the specifications are covered in Section IV Performance Tests. Table 1-2 lists general information. General information is not specifications but is typical characteristics included as additional information for the operator. When the 4261A LCR Meter is shipped from the factory, it meets the specifications listed in Table 1-1.

1-6. SAFETY CONSIDERATIONS.

1-7. The Model 4261A LCR Meter has been designed to conform to the safety requirements of an IEC (International Electromechanical Committee) Safety Class I instrument.

1-8. This operating and service manual contains information, cautions and warnings which must be followed by the user to ensure safe operation and to maintain the instrument in a safe condition.

4261A
Digital LCR Meter

Power Cable
(HP P/N: 8120-1378)

Figure 1-1. Instrument and Accessories Supplied.

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Table 1-1. Specifications (Sheet 1 of 2).

COMMON SPECIFICATIONS

Parameters Measured: C-D, L-D and R.

Display: 3 1/2 Digits, Max. Display 1900

Circuit Modes: Auto, Parallel and Series.

Measurement Circuit: Five-terminal Method.

Range Mode: Auto or Range Hold.

Measurement Frequencies:
120Hz ±3%
1kHz ±3%

Trigger: Internal, Manual or External.

C-D MEASUREMENT

Range										
	C	120Hz 1kHz	1000pF 100.0pF	10.00nF 1000pF	100.0nF 10.00nF	1000nF 100.0nF	10.00μF 1000nF	100.0μF 10.00μF	1000μF 100.0μF	10.00mF 1000μF
	D	0.001 to 1.900, 1 range, common to all C ranges								
Test Signal Level *1		1V or 50mV								
		—				10μA	100μA	1mA	10mA	70mA
	AUTO	Same as Mode					Same as Mode			
C Accuracy *2 *3		0.2% + 1 count + 0.2pF					(Test signal level; 1V)			
		0.5% + 3 counts	0.3% + 2 counts				(Test signal level; 50mV)			
		—			0.3% + 2 counts			0.5% + 2counts	1% + 2counts *4	
	AUTO	Same as Mode					Same as Mode			
D Accuracy *2		0.2% + (2 + 200/Cx) counts					(Test signal level; 1V)			
		—	0.3% + (2 + 1000/Cx) counts				(Test signal level; 50mV)			
		—			0.3% + (2 + Cx/500) counts				1% + (5 + Cx/500) counts	
	AUTO	Same as Mode					Same as Mode			

*1. Typical data, varies with value of D and number of counts.
*2. ± (% of reading + counts + α). Cx is capacitance readout in counts.
*3. C accuracies are applicable only when D value is less than 1.901. See Table 1-2 for C accuracies when D is more than 1.900.
*4. 5% + 2 counts at 1kHz.

Accuracy applies over a temperature range of 23°C ±5°C (at 0°C to 55°C, error doubles).

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Table 1-1. Specifications (Sheet 2 of 2).

L-D MEASUREMENT

Range									
	L	120Hz 1kHz	1000μH 100.0μH	10.00mH 1000μH	100.0mH 10.00mH	1000mH 100.0mH	10.00H 1000mH	100.0H 10.00H	1000H 100.0H
	D	0.001 to 1.900, 1 range, common to all L ranges.							
Test Signal Level *1			1V						
			70mA	10mA	1mA	100μA	10μA		
		AUTO	Same as Mode				Same as Mode		
L Accuracy *2 *3			0.3% + 2 counts				1% + 2 counts		
			0.2% + 2 counts + 0.2μH						
		AUTO	Same as Mode				Same as Mode		
D Accuracy *2			0.3% + (3 + Lx/500) counts				1% + (3 + $\frac{Lx}{500}$) counts		
			0.2% + (3 + 200/Lx) counts						
		AUTO	Same as Mode				Same as Mode		

*1. Typical data, varies with value of D and number of counts.
*2. ± (% of reading + counts). Lx is inductance readout in counts.
*3. L accuracies are applicable only when D value is less than 1.901. See Table 1-2 for L accuracies when D is more than 1.900.

R MEASUREMENT

RANGE	120Hz or 1kHz	1000mΩ	10.00Ω	100.0Ω	1000Ω	10.00kΩ	100.0kΩ	1000kΩ	10.00MΩ
Test Signal Level *1		1V							
		70mA	10mA	1mA	100μA	10μA			
	AUTO	Same as Mode				Same as Mode			
R Accuracy *2 *3		0.3% + 2 counts							
		0.2% + 2 counts							
	AUTO	Same as Mode				Same as Mode			

*1. Typical data, varies with number of counts.
*2. ± (% of reading + counts).
*3. R accuracies are applicable only when D value measured in L or C function is greater than 0.500. See Table 1-2 for R accuracies when D is less than 0.501.

Accuracy applies over a temperature range of 23°C ±5°C (at 0°C to 55°C, error doubles).

DC BIAS

Internal Source: 1.5V, 2.2V, 6V (Accuracy ±5%).

External Source: Provision for external DC bias voltage of +30V maximum at binding posts on rear panel.

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Table 1-2. General Information (Sheet 1 of 2).

READING RATE

The period between the start of a measurement and the start of next measurement is equal to the measuring time plus 30 milliseconds (typical) hold time.

MEASURING TIME

The period between start of a *measurement* and completion of the measurement is equal to measuring time when RANGE HOLD is set to ON (see figure below) plus time required for autoranging. The following are typical times for a measurement of approximately 1000 counts on low loss components when RANGE HOLD is set to ON.

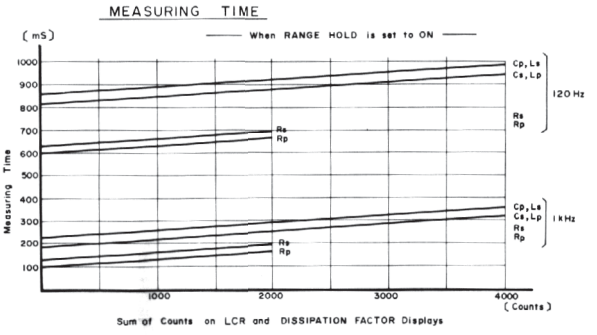
Time required for autoranging (RANGE HOLD: OFF):

1kHz: 180 x n (ms)

120Hz: 670 x n (ms)

where n is the number of ranges stepped by 4261A autorange circuit.

1kHz	C/L	220 - 260ms
	R	120 - 160ms
120Hz	C/L	900ms
	R	700ms



L-D/C-D Accuracies when D > 1.900 and R accuracies when D ≤ 0.500:

For L-D/C-D accuracies when D > 1.900 and R accuracies when D ≤ 0.500, the following error factors should be added to accuracy specifications:

Note

1. D display is blanked when Cp or Ls value is less than 80 counts.
2. Both displays will show 1999 counts and "OUT OF RANGE" lamp will light when measured value for Cs, Lp or Rp is less than about 60 counts (right display is blanked during R measurements).

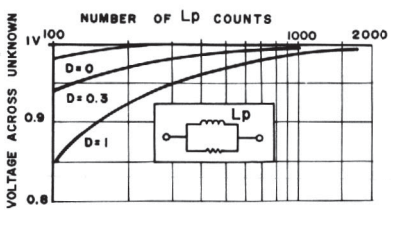
CIRCUIT MODE	Additional Error
Parallel Capacitance	D/10 % of reading (Test Sig Level: 1V) D/5 % of reading (Test Sig Level: 50mV)
Series Capacitance	D/5 % of reading
Parallel Inductance Series Inductance	D/5% of reading
Parallel Resistance Series Resistance	0.2/D % of reading

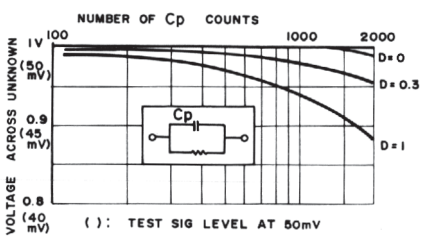
TEST SIGNAL LEVEL

Voltage applied to sample under test and current flow through sample are to some extent changed by value and dissipation factor of the sample.

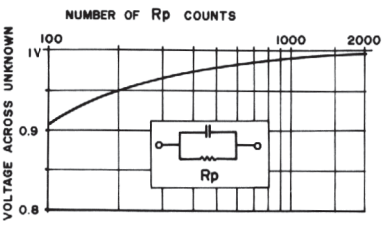
Parallel Equivalent Mode (Lp, Cp, Rp)

Since the output of constant voltage driver is somewhat affected by sample, the voltage across sample varies as shown in below charts:





Note: These charts assume that impedance between HIGH terminals and ground is infinite.



Note: This chart assumes that impedance between HIGH terminals and ground is infinite and that unknown device is an almost pure resistance.

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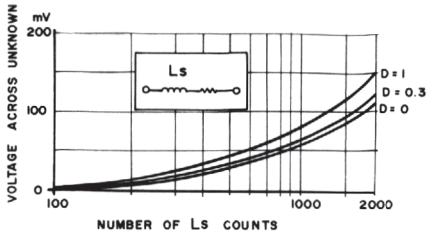
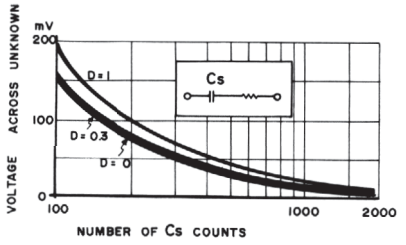
Table 1-2. General Information (Sheet 2 of 2).

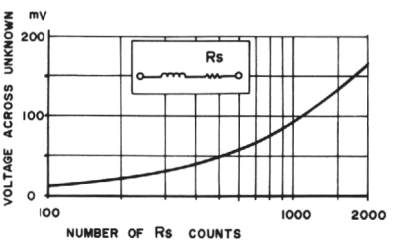
Series Equivalent Mode (Ls, Cs, Rs)

The constant current source built into the 4261A is affected by the sample. Voltage across sample also varies with the value and dissipation factor of the sample as shown in below charts:





Note: These charts assume that impedance between HIGH terminals and ground is infinite.



Note: This chart assumes that impedance between HIGH terminals and ground is infinite and that unknown device is an almost pure resistance.

TRIGGER

Internal: When TRIGGER switch is set to INT position, the 4261A triggers itself automatically at reading rate speed.

Manual: When TRIGGER is set to EXT position, the 4261A is triggered every time the MANUAL button is depressed and released.

External: When TRIGGER is set to EXT position, the 4261A is triggered by the trailing edge of a TTL level negative going pulse applied to EXT TRIGGER input connector on rear panel or by opening center conductor of EXT TRIGGER connector after earthing. Negative pulse width of trigger should be more than 20 μs.

External Encode: When the 4261A is equipped with any option, it may be triggered by an external device. The 4261A is triggered by the trailing edge of a TTL level negative going pulse from the external device. Negative pulse width for External Encode signal should be more than 20 μs.

WARM-UP TIME

Approximately 15 minutes.

Note

Measurement accuracy is not affected by dc bias application from either internal or external bias sources ($\leq$ 200V).

OPTIONS

Option 001: BCD Output of C/L/R and D (Simultaneous)

Option 002: BCD Output of C/D, L/D and R (Alternately)
Data (C/L/R or D) separately selectable by switch on internal board (04261-77022).

Option 003: BCD Remote Control (except for DC bias function)

ACCESSORIES AVAILABLE

16061A: Test Fixture (direct coupled type), 5-terminal construction.

16062A: Test Leads with alligator clips, 4-terminal construction (for low impedance measurements).

16063A: Test Leads with alligator clips, 3-terminal construction (for high impedance measurements).

OTHER

Operating Temperature:

0° C to 55° C (32° F to 131° F)

Operating Humidity:

Relative humidity less than 95% at 40° C.

Altitude: 50, 000ft.

Power:

100/120/220/240Vac ±10%, 48 to 66Hz

Power Consumption: approximately 25VA (including optional configurations).

Dimensions:

Approximately 213(w) x 134 (h) x 422 (d) mm.

Weight: approximately 7.5kg.

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1-9. INSTRUMENTS COVERED BY MANUAL.

1-10. Hewlett-Packard uses a two-section nine character serial number which is marked on the serial number plate (Figure 1-2) attached to the instrument rear panel. The first four digits and the letter are the serial prefix and the last five digits are the suffix. The letter placed between the two sections identifies country where instrument was manufactured. The prefix is the same for all identical instruments; it changes only when a change is made to the instrument. The suffix, however, is assigned sequentially and is different for each instrument. The contents of this manual apply to instruments with the serial number prefix(es) listed under SERIAL NUMBERS on the title page.

1-11. An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates the instrument is different from those described in this manual. The manual for this new instrument may be accompanied by a yellow Manual Changes supplement or have a different manual part number. This supplement contains "change information" that explains how to adapt the manual to the newer instrument.

1-12. In addition to change information, the supplement may contain information for correcting errors (called Errata) in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement. The supplement for this manual is identified with this manual's print date and part number, both of which appear on the manual's title page. Complimentary copies of the supplement are available from Hewlett-Packard. If the serial prefix or number of an instrument is lower than that on title page of this manual, see Section VII Manual Changes.

1-13. For information concerning a serial number prefix that is not listed on the title page or in the Manual Changes supplement, contact your nearest Hewlett-Packard office.

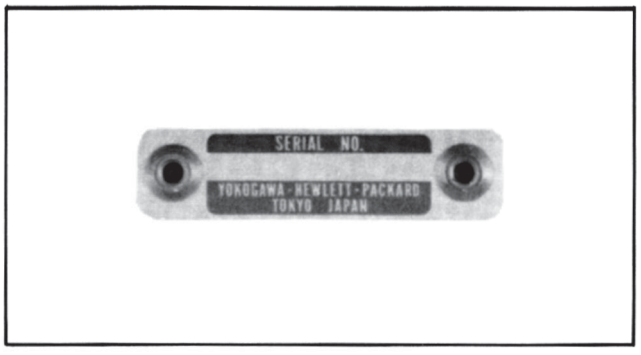

Figure 1-2. Serial Number Plate.

1-14. DESCRIPTION.

1-15. The HP Model 4261A LCR Meter is a general purpose, easy-to-use, high reliability component test instrument designed to automatically measure the parameters of an impedance element with high accuracy and at high speed. The 4261A LCR Meter measures capacitance, inductance, resistance and dissipation factor over a wide range at test frequencies of 120Hz and 1kHz in a five-terminal connection configuration between the component and the instrument. The measuring circuit for the device to be measured is capable of both parallel and series equivalent circuit measurements and the measured values are displayed on two three-full digits LED displays on the front panel.

1-16. The measuring range for capacitance is from 0.1pF to 19mF, inductance from 0.1μH to 1900H, and resistance from 1mΩ to 19MΩ all of which are measured with a basic accuracy of 0.2 to 0.3% depending on test signal level, frequency and measuring equivalent circuit, and at a typical measuring speed of 200 milliseconds. The wide range capability of the 4261A enables a measurement range from small capacitances such as mica capacitors and the parasitic capacitance of a semiconductor device through high capacitances such as the measurement of electrolytic capacitors to be covered. A wide range of inductance measurements from the inductance of a high frequency transformer to that of a power transformer can be measured. The wide resistance range permits the measurement of wirewound resistors through the measurement of solid resistors. In parallel capacitance measurements, the 4261A Digital LCR Meter can select either a test signal level of 1Vrms, or 50mVrms. Other versatile 4261A capabilities are, for example, the use of internal and external dc bias voltages, the availability of test fixtures, and options providing for BCD output and remote control operation (at the rear panel).

1-17. OPTIONS.

1-18. Options for the Model 4261A LCR Meter are available for adding BCD parallel data output at two rear panel connectors (opt 001), for providing a BCD parallel data output connector on the rear panel (opt 002), and for attaching a rear panel input connector for remote control of the 4261A (opt 003). Detailed descriptions of the various options follow.

1-19. Option 001.

1-20. The 4261A Option 001 provides separate BCD parallel data output of capacitance, inductance or resistance and dissipation factor simultaneously from the two rear connectors. With this option, external data processing devices such as digital printer/comparators can be connected to the 4261A Digital LCR Meter. Table 1-3 lists the components required for installation of this option to a standard unit.

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Table 1-3. 4261A Options.

Option	Function	Components		
		HP Part No.	Q'ty	Description
Option 001	BCD Parallel Data Output	04261-77021 5060-4020	1 2	A21 Board Ass'y Connector Assembly 50-pin
Option 002	Parameter Serial BCD Data Output	04261-77022 5060-4020 04261-85023	1 1 1	A22 Board Ass'y Connector Assembly 50-pin Name Plate
Option 003	BCD Remote Control	04261-77123 04261-72023	1 1	Connector Ass'y 50-pin 50-pin Flat Cable Ass'y

1-21. Option 002.

1-22. The 4261A Option 002 provides for outputting inductance, capacitance or resistance and dissipation factor values as measured with the 4261A LCR Meter alternately from one rear connector in BCD data parallel form. When the 4261A is equipped with an option 002, a digital printer, digital comparator or other such external devices can be interfaced. The components required for installation of option 002 with a standard 4261A are listed in Table 1-3.

1-23. Option 003.

1-24. The 4261A option 003 adds remote control capability to the 4261A permitting external control of FUNCTION, RANGE, etc. functions at a rear input connector for combination with an external control device. Table 1-3 shows the components needed for installation of the Option 003.

1-25. Option 010.

1-26. The 4261A Option 010 changes 120Hz standard measurement frequency to 100Hz. All specifications given in Table 1-1 apply directly to Option 010 instruments equipped with 100Hz and 1kHz measurement frequencies. Change all 120Hz descriptions to 100Hz.

1-29. ACCESSORIES SUPPLIED.

1-30. Figure 1-1 shows the HP Model 4261A LCR Meter, power cord (HP Part No. 8120-1378), fuses (HP Part No. 2110-0201 and 2110-0202), and the Operating and Service Manual.

1-31. EQUIPMENT AVAILABLE.

1-32. Three styles of fixtures and leads for the measurement of various components are available for effective and easy measurement. These are listed in Table 1-2. A brief description of each of these fixtures and leads is given in Table 1-4. Refer to Section III paragraph 3-10 for detailed information on these devices.

1-33. RECOMMENDED TEST EQUIPMENT.

1-34. The equipment required to maintain the Model 4261A is listed in Table 1-4. Other equipment may be substituted if it meets or exceeds the critical specifications listed in the table.

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Table 1-4. Equipment Available.

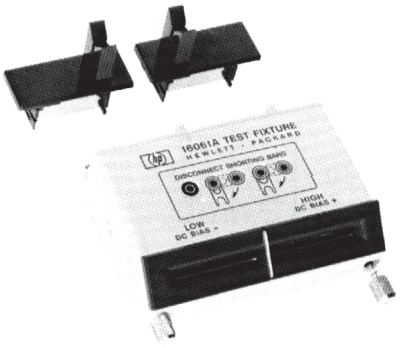
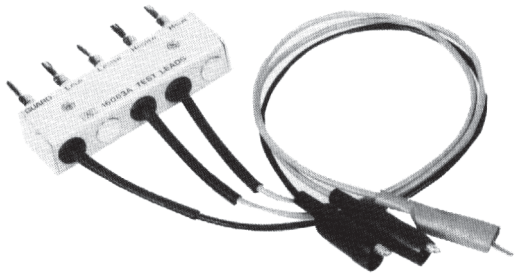
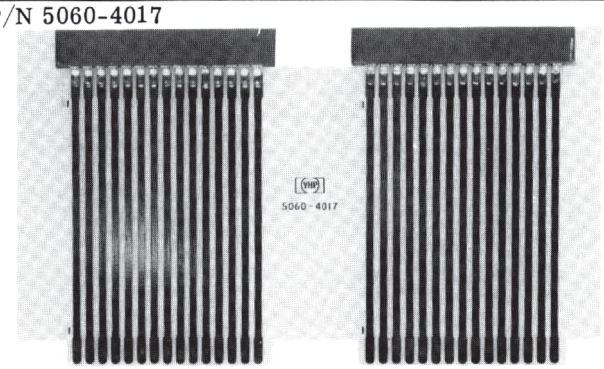
Model	Description
HP 16061A 	Test Fixture (direct coupled type) for general measurement of both axial and vertical lead components.
HP 16062A	Test Leads (with alligator clips) useful for low inductance, high capacitance or low resistance (less than 10kΩ) measurements.
HP 16063A 	Test Leads (with alligator clips) for general component measurement and especially useful for high impedance measurements.
HP P/N 5060-4017 	Extender Board used for 4261A troubleshooting.

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Table 1-5. Recommended Test Equipment.

Instrument	Critical Specifications	Recommended Model	*Use
Frequency Counter	Frequency Range: 40Hz to 10kHz Sensitivity: 50mVrms min.	HP 5300A/ w5306A	P
Capacitance Standard (See para. 4-3)	Capacitance Values: 100pF, 1000pF, 10nF 100nF, 1000nF and 10μF	HP 16361A	P, A
Resistance Standard (See para. 4-3)	Resistance Values: 1kΩ, 10kΩ, 100kΩ and 10MΩ	HP 16361A	P, A
Inductance Standard (See para. 4-3)	Inductance Value: 100mH	HP 16361A	P
DC Voltmeter	Voltage Range: 1V to 10V Sensitivity: 10mV min.	HP 5300A/ w5306A	P, A
Oscilloscope	Bandwidth: 10MHz min. Vertical Sensitivity: 5mV/div. Horizontal Sweep Rate: 1μs/div.	HP 180C/ w 1801A/ w 1821A	A
Logic State Analyzer	Repetition Rate: 0 to 1MHz Input Threshold: TTL (approx. +1.5V) Minimum Clock Pulse Width: 1μs	HP 1601A/ w 180C HP 1600A	T
Logic Probe	Input Impedance: >25kΩ Logic one Threshold: 2V $\pm$0.2V Logic zero Threshold: 0.8V +0.2V, -0.4V Input Minimum Pulse Width: 1μs	HP 10525T	T

*P = Performance Test A = Adjustments T = Troubleshooting

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SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section provides installation instructions for the Model 4261A LCR Meter. The section also includes information on initial inspection and damage claims, preparation for using the 4261A and packaging, storage and shipment.

2-3. INITIAL INSPECTION.

2-4. The 4261A LCR Meter as shipped from the factory meets all the specifications listed in Table 1-1. On receipt, inspect the shipping container for damage. If the shipping container or cushioning material is damaged, notify the carrier as well as the Hewlett-Packard office and be sure to keep the shipping materials for carrier's inspection until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. The contents of the shipment should be as shown in Figure 1-1. The procedures for checking the general electrical operation are given in Section III (Paragraph 3-5 OPERATOR'S CHECK) and the procedures for checking the 4261A LCR Meter against its specifications are given in Section IV. Firstly, do the operator's check. If the 4261A LCR Meter is electrically questionable then do the Performance Tests to determine whether the 4261A has failed or not. If contents are incomplete, if there is mechanical damage or defects (scratches, dents, broken switches, etc.), or if the performance does not meet the operator's or performance tests, notify the nearest Hewlett-Packard office (see list at back of this manaul). The HP office will arrange for repair or replacement without waiting for claim settlement.

2-5. PREPARATION FOR USE.

2-6. Power Requirements.

2-7. The 4261A requires a power source of 100, 120, 220, or 240Volts ac ±10%, 48 to 66Hz single phase. Power consumption is approximately 25 watts.

WARNING

IF THIS INSTRUMENT IS TO BE ENERGIZED VIA AN EXTERNAL AUTOTRANSFORMER FOR VOLTAGE REDUCTION, BE SURE THAT THE COMMON TERMINAL IS CONNECTED TO THE NEUTRAL POLE OF THE POWER SUPPLY.

2-8. Line Voltage and Fuse Selection.

CAUTION

BEFORE TURNING THE 4261A LINE SWITCH TO ON, VERIFY THAT THE INSTRUMENT IS SET TO THE VOLTAGE OF THE POWER SUPPLIED.

2-9. Figure 2-1 provides instructions for line voltage and fuse selection. The line voltage selection card and the proper fuse are factory installed for the voltage appropriate to instrument destination.

CAUTION

USE PROPER FUSE FOR LINE VOLTAGE SELECTED.

CAUTION

MAKE SURE THAT ONLY FUSES FOR THE REQUIRED RATED CURRENT AND OF THE SPECIFIED TYPE ARE USED FOR REPLACEMENT. THE USE OF MENDED FUSES AND THE SHORT-CIRCUITING OF FUSEHOLDERS MUST BE AVOIDED.

2-10. Power Cable.

2-11. To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends that the instrument panel and cabinet be grounded. The Model 4261A is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable is the ground wire.

2-12. To preserve the protection feature when operating the instrument from a two contact outlet, use a three prong to two prong adapter (HP Part No. 1251-8196) and connect the green grounding tab on the adapter to power line ground.

CAUTION

THE MAINS PLUG MUST ONLY BE INSERTED IN A SOCKET-OUTLET PROVIDED WITH A PROTECTIVE EARTH CONTACT. THE PROTECTIVE ACTION MUST NOT BE NEGATED BY THE USE OF AN EXTENSION CORD (POWER CABLE) WITHOUT PROTECTIVE CONDUCTOR (GROUNDING).

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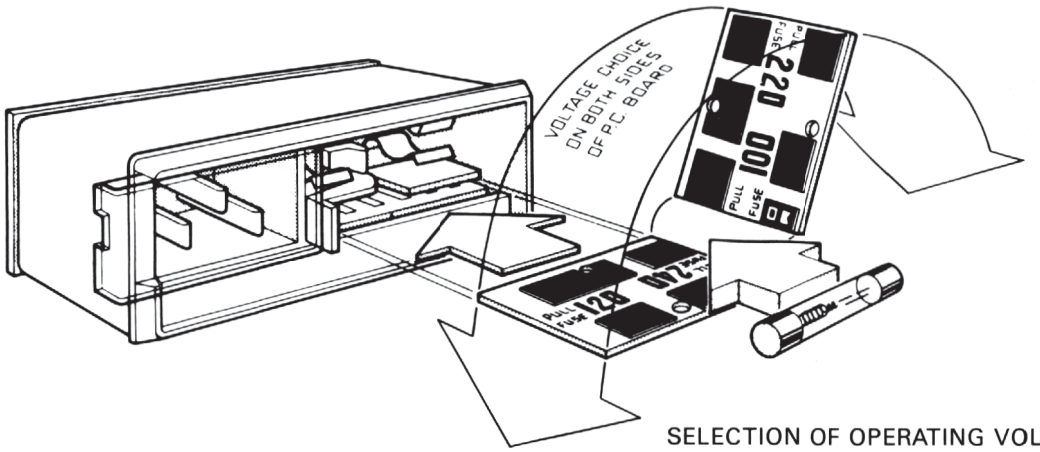
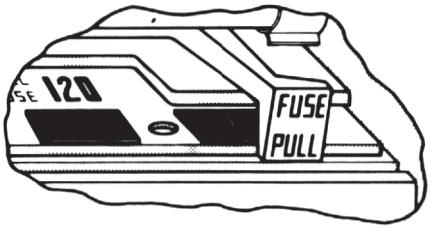


Operating voltage is shown in module window and is usually set to 120V at factory.



SELECTION OF OPERATING VOLTAGE

1. Disconnect power cable and slide module window to left.
2. Pull FUSE PULL lever and rotate to left. This removes line fuse.
3. Select operation voltage by orienting PC board to position desired voltage on top-left side. Push board firmly into module slot.
4. Rotate FUSE PULL lever back into normal position and re-insert fuse in holders, using caution to select correct fuse value.

FUSE SELECTION

Operating Voltage	Fuse	
	HP Part No.	Description
100Vac or 120Vac	2110-0202	0.5A 250V Slow Blow
220Vac or 240Vac	2110-0201	0.25A 250V Slow Blow

Figure 2-1. Voltage and Fuse Selection.

Table 2-1. Mating Connectors.

Mating Connector	Industry Description	HP Part No.	Alternate Source
C OFFSET	BNC, male	1250-0408	
EXT TRIGGER			
DC BIAS	Dual Banana Plug	1251-2816	
LCR DATA OUTPUT	Micro-Ribbon 50-pin	1251-0086	Amphenol 57-30500-375
D DATA OUTPUT			
REMOTE INPUT			

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2-13. Figure 2-2 shows the available power cords, which may be used in various countries including the standard power cord furnished with the instrument. HP Part number, applicable standards for power plug, power cord color, electrical characteristics and countries using each power cord are listed in the figure. If assistance is needed for selecting the correct power cable, contact nearest Hewlett-Packard office.

2-14. Interconnections.

2-15. When an external bias is applied to the sample capacitor through DC BIAS input connectors on the 4261A rear panel, both plus and minus sides of the external power supply should be connected to the plus and minus connectors of the 4261A DC BIAS input connectors, respectively.

CAUTION

THE MAINS PLUG MUST BE INSERTED BEFORE EXTERNAL CONNECTIONS ARE MADE TO MEASURING AND/OR CONTROL CIRCUITS.

2-16. Mating Connectors.

2-17. The mating connectors used for the 4261A are shown in Table 2-1. This table identifies each connector and gives the HP Part Number and part number of an alternate source.

2-18. Operating Environment.

2-19. Temperature. The instrument may be operated in temperatures from 0° C to +55° C.

2-20. Humidity. The instrument may be operated in environments with relative humidities to 95% to 40° C. However, the instrument should also be protected from temperature extremes which cause condensation within the instrument.

2-21. Installation Instructions.

2-22. The HP Model 4261A can be operated on the bench or in a rack mount. The 4261A is ready for bench operation as shipped from the factory. For bench operation a two-leg instrument stand is used. When in use, the instrument stands are designed to be pulled towards the front of instrument.

2-23. Rack Mounting and Handle Installation.

2-24. The 4261A can be installed in a rack and be operated as a component of a measurement system. Rack mounting information for the 4261A is presented in Figure 2-3. Various rack mounting configurations are shown with the necessary additional parts. To convert for rack installation or to install handles, refer to Figure 2-3 and proceed as follows:

a. Remove the two rear feet and the two front feet with stands.

b. Follow the instructions in Figure 2-3 for desired installation.

2-25. STORAGE AND SHIPMENT.

2-26. Environment.

2-27. The instrument may be stored or shipped in environments within the following limits:

Temperature	-40° C to +75° C
Humidity	to 95%
Altitude	50, 000ft

The instrument should also be protected from temperature extremes which cause condensation inside the instrument.

2-28. Packaging.

2-29. Original Packaging. Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. Also mark the container FRAGILE to assure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

2-30. Other Packaging. The following general instructions should be used for re-packing with commercially available materials:

a. Wrap instrument in heavy paper or plastic. If shipping to Hewlett-Packard office or service center, attach tag indicating type of service required, return address, model number, and full serial number.

b. Use strong shipping container. A double-wall carton made of 350 pound test material is adequate.

c. Use enough shock absorbing material (3 to 4 inch layer) around all sides of instrument to provide firm cushion and prevent movement inside container. Protect control panel with cardboard.

d. Seal shipping container securely.

e. Mark shipping container FRAGILE to ensure careful handling.

f. In any correspondence, refer to instrument by model number and full serial number.

2-31. OPTION INSTALLATION.

2-32. When it is desired to add one of the avaialble optional features to a standard 4261A instrument, perform the installation as follows:

a. Push LINE switch to OFF.

b. Remove instrument top cover.

c. Follow the appropriate paragraph below:

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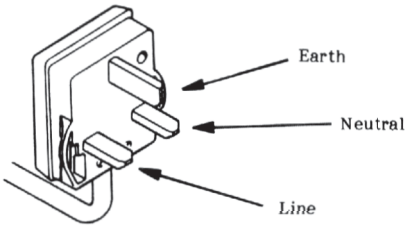
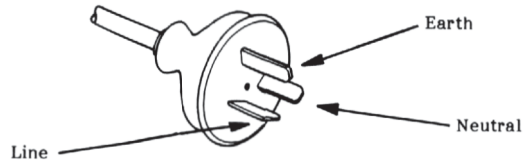
OPTION 900 United Kingdom



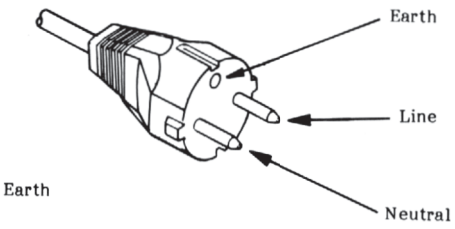
Plug : BS 1363A, 250V
Cable : HP 8120-1351

OPTION 901 Australia/New Zealand



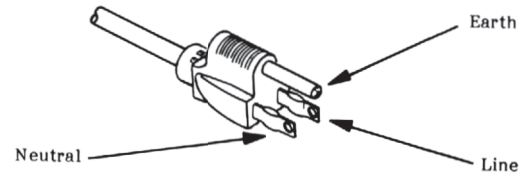
Plug : NZSS 198/AS C112, 250V
Cable : HP 8120-1369

OPTION 902 European Continent



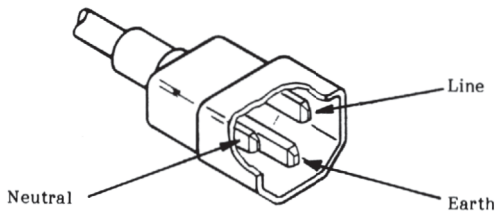
Plug : CEE-VII, 250V
Cable : HP 8120-1689

OPTION 903 U.S./Canada



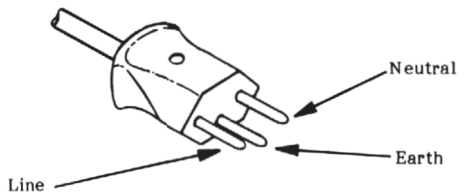
Plug : NEMA 5-15P, 125V, 15A
Cable : HP 8120-1378

OPTION 905* Any country



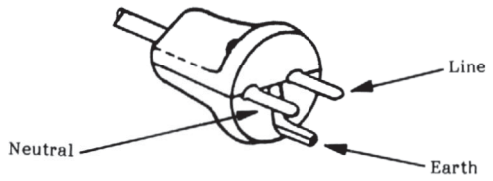
Plug : CEE 22-VI, 250V
Cable : HP 8120-1396

OPTION 906 Switzerland



Plug : SEV 1011.1959-24507 Type 12, 250V
Cable : HP 8120-2104

OPTION 912 Denmark



Plug : DHCR 107, 220V
Cable : HP 8120-2956

* Plug option 905 is frequently used for interconnecting system components and peripherals.

NOTE: Each option number includes a 'family' of cords and connectors of various materials and plug body configurations (straight, 90 ° etc.)

Figure 2-2. Power Cables Supplied.

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2-33. Option 001 BCD Parallel Data Output Installation.

a. Remove the two top blind covers from the rear panel.

b. Install two 50-pin Connector Assemblies in the openings as shown in Figure 2-4.

c. Insert A21 Board Assembly into optional receptacle (see Figure 2-4).

d. Plug flat cable assemblies from option board to connector boards of Connector Assemblies.

2-34. Option 002 Parameter Serial BCD Data Output Installation.

a. Remove top blind cover on rear panel.

b. Install a 50-pin Connector/Board Assembly in the opening as shown in Figure 2-4.

c. Insert A22 Board Assembly into optional plug-in receptacle (see Figure 2-4).

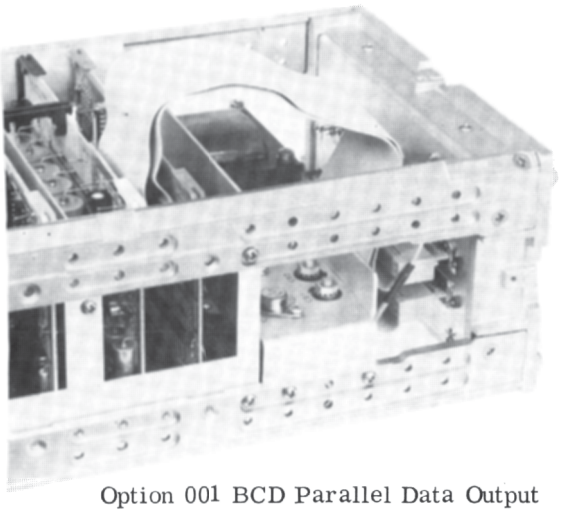
d. Plug flat cable assembly from option board to connector board of Connector Assembly.

2-35. Option 003 BCD Remote Control Installation.

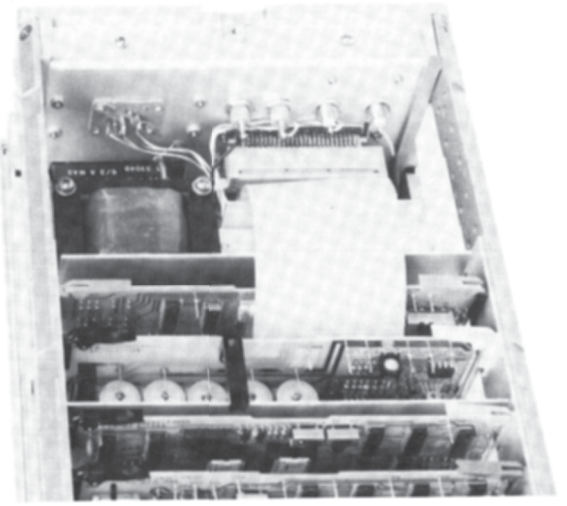
a. Remove instrument bottom cover and bottom blind cover from rear panel.

b. Install connector assembly in the opening.

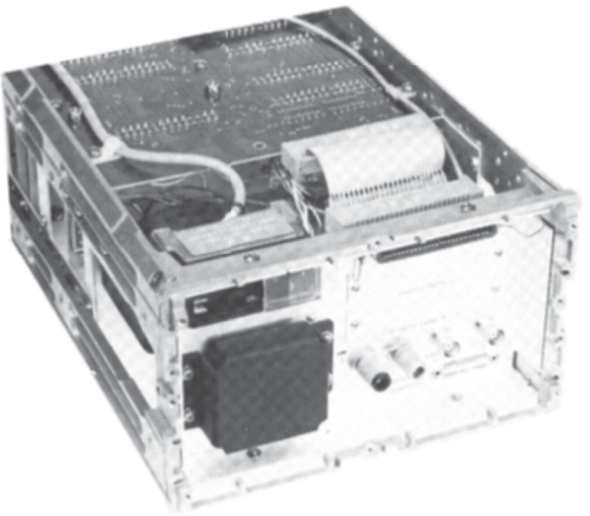
c. Connect the flat cable assembly between connector board of connector assembly and A1 Mother board (see Figure 2-4).



Option 001 BCD Parallel Data Output



Option 002 Parameter Serial BCD Data Output



Option 003 BCD Remote Control

Figure 2-4. Option Installations.

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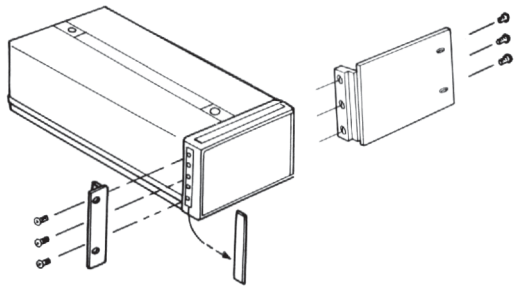
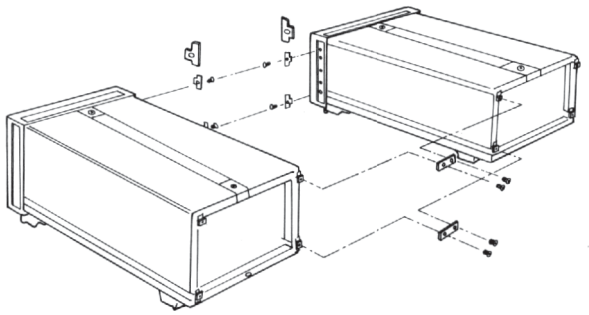
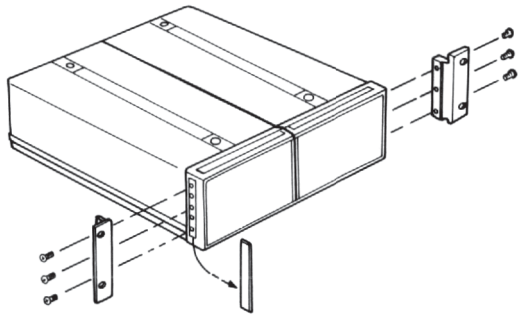


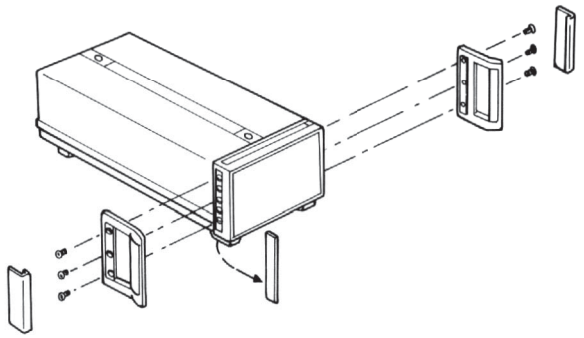
(A)



(B)



(C)



(D)

A. Rack Installation (only 4261A)

1. Remove the two plastic side trim strips from front frame.
2. Attach flange and adapter panel assembly with screws.

Parts required:

HP Part No.	Q'ty	Description
5061-0057	1	Rack Adapter Kit

B. Horizontal Lock Installation

1. Remove the plastic side trim strips from front frame.
2. Attach front horizontal lock links to side of front frames.
3. Connect the two instruments together and attach rear lock links to rear panels.

Parts required:

HP Part No.	Q'ty	Description
0050-0515	4	front horizontal lock link
2510-0192	4	screw
0050-0516	2	rear horizontal lock link
2360-0360	4	screw

C. Rack Installation for Horizontally Locked Unit

1. Remove the plastic side trim strips from front frame.
2. Attach flanges with screws.

Parts required:

HP Part No.	Q'ty	Description
5061-0077	1	Rack Flange Kit
Plus all parts needed for B.		

D. Handle Installation

1. Remove the plastic side trim strips from front frame.
2. Attach handles with screws.

Parts required:

HP Part No.	Q'ty	Description
5061-0089	1	Handle Kit

Figure 2-3. Rack and Handle Installation (Sheet 1 of 2).

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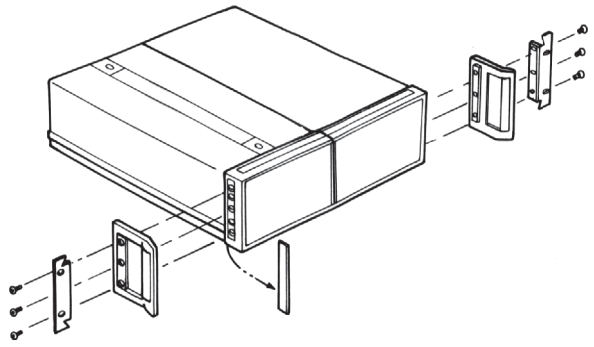

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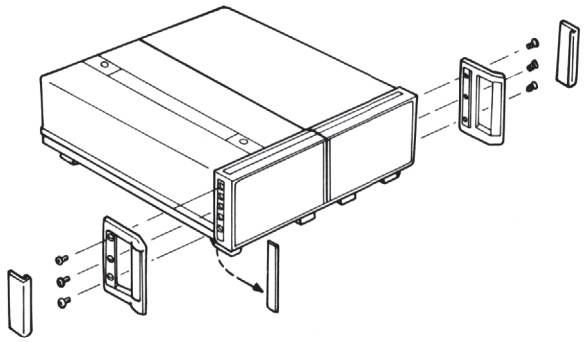

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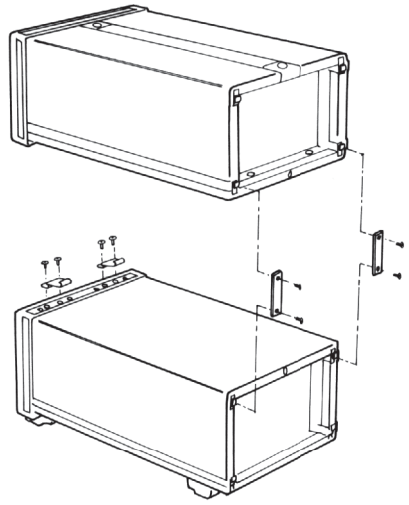

(G)

E. Handle and Rack Installation for Horizontally Locked Unit

1. Remove front side trim strips from front frame.
2. Attach Handles with screws.
3. Attach flanges with screws.

Parts required:

HP Part No.	Q'ty	Description
5061-0083	1	Handle Kit
Plus all parts needed for B.		

F. Handle Installation for Horizontally Locked Unit

1. Remove front side trim strips from front frame.
2. Attach handles with screws.

Parts required:

HP Part No.	Q'ty	Description
5061-0089	1	Handle Kit
Plus all parts needed for B.		

G. Vertical Lock Installation

1. Remove top trim strips from front frame of bottom instrument.
2. Attach front vertical lock links.
3. Connect the two instruments together and attach rear vertical lock links with screws.

Parts required:

HP Part No.	Q'ty	Description
1600-0367	2	front vertical lock link
2360-0330	4	screw
0050-0517	2	rear vertical lock link
2360-0360	4	screw

Figure 2-3. Rack and Handle Installation (Sheet 2 of 2).

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SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. This section provides the operating information to acquaint the user with the 4261A LCR Meter. Basic product features and characteristics, measurement procedures for various applications, an operational check of the fundamental electrical functions and operator maintenance information are presented in this section. Operating cautions throughout the text should be carefully observed.

3-3. PANEL FEATURES.

3-4. Front and rear panel features for the 4261A are described in Figures 3-1 and 3-2. Description numbers match the numbers on the photograph. Other detailed information for panel displays and controls are covered in the Operating Instructions (paragraph 3-7).

3-5. OPERATING CHECK.

WARNING

ANY INTERRUPTION OF THE PROTECTIVE CONDUCTOR INSIDE OR OUTSIDE THE INSTRUMENT OR DISCONNECTION OF THE PROTECTIVE EARTH TERMINAL IS LIKELY TO CAUSE THE INSTRUMENT TO BE DANGEROUS. INTENTIONAL INTERRUPTION IS PROHIBITED.

WARNING

WHENEVER IT IS LIKELY THAT THE PROTECTION OFFERED BY FUSES HAS BEEN IMPAIRED, THE INSTRUMENT MUST BE MADE INOPERATIVE AND BE SECURED AGAINST ANY UNINTENDED OPERATION.

CAUTION

BEFORE ANY OTHER CONNECTION IS MADE, THE PROTECTIVE EARTH TERMINAL MUST BE CONNECTED TO A PROTECTIVE CONDUCTOR.

3-6. Figure 3-3, Operating Check procedure, may be performed as an incoming inspection or when the user wants to determine that the instrument works properly before making a measurement. If the instrument is suspected to be faulty during the operating check, it is best to repeat the check to verify the trouble and to clearly establish the symptoms and then to advance to the troubleshooting guide provided in Section VIII SERVICE or to performance tests in Section IV.

3-7. OPERATING INSTRUCTIONS.

3-8. General Operating Information.

3-9. Connecting DUT. The 4261A UNKNOWN terminals consist of five connectors; HCUR, HPOTEN, LCUR, LPOTEN and GUARD. These terminals are sometimes converted to a three terminal configuration including GUARD terminal. A four-terminal measurement configuration, which is useful for accurate low inductance, high capacitance or low resistance measurement, is also feasible. When converting to three terminals, shorting bars are attached to the instrument combine HCUR and HPOTEN terminals, and LCUR and LPOTEN terminals, respectively.

CAUTION

FOR CERTAIN TERMINAL MEASUREMENT CONFIGURATIONS, THE HCUR TERMINAL MUST BE CONNECTED TO HPOTEN TERMINAL AND THE LCUR TERMINAL CONNECTED TO THE LPOTEN TERMINAL. OTHERWISE THE DISPLAYS WILL HAVE NO MEANING AND THE LIFE OF THE RELAYS USED IN THE INSTRUMENT WILL SOMETIMES BE SHORTENED.

Note

The 4261A can not measure a sample which has one lead connected to earth (grounded).

3-10. Test Fixtures and Leads.

3-11. The 4261A has three kinds of test fixtures and leads available. These are described in Table 3-1. The characteristics of the sample to be measured should determine which accessory should be selected. In a similar way to these available accessories, user built test fixtures or leads may be constructed for special measurement requirements.

3-12. Measuring Circuit Modes. The circuit mode which treats and measures the unknown as a parallel capacitance is called the Cp (parallel capacitance) mode, and in like manner, the other measuring modes are:

Cs mode: series capacitance.

Lp mode: parallel inductance.

Ls mode: series inductance.

Rp mode: parallel resistance.

Rs mode: series resistance.

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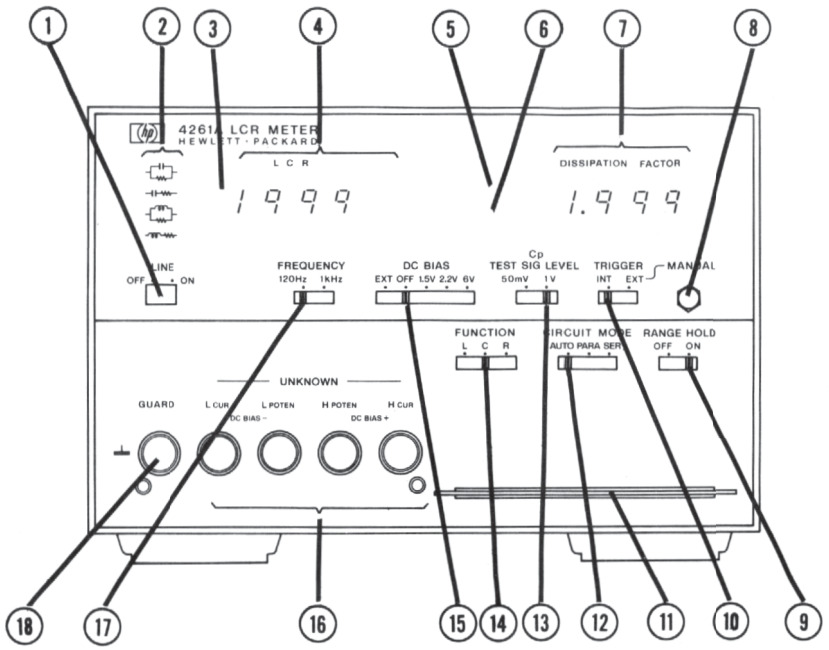
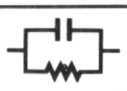


(1) LINE ON/OFF switch: Turns instrument on and readies instrument for measurement.

(2) Circuit Mode Indicator: LED lamp, next to equivalent measuring circuit being used, lights. Sample connected to UNKNOWN terminals (16) is measured in an equivalent circuit selected by FUNCTION (14) and CIRCUIT MODE (12) switches and is indicated by appropriate LED lamp. Equivalent circuits are shown as electronic circuit symbols at the left of indicator lamps. Desired circuit parameter of component is measured in one of the following selected circuit modes:

Parallel capacitance Parallel resistance	
Series capacitance	
Parallel inductance	
Series inductance Series resistance	

(3) Trigger Lamp: Turns on during sample measuring period. Turns off during period when instrument is not taking measurement (or hold period). There is one turn-on-and-off cycle per measurement. This lamp turns on and off repeatedly when TRIGGER (10) is set to INT.

(4) LCR Display: Inductance, capacitance or resistance value including the decimal point and unit is displayed by this 3-1/2 digit display. Displayed counts over the range between 0 and 1900 have meaning and number counts outside this range are meaningless. Both LCR (4) and DISSIPATION FACTOR displays (7) will indicate 1999 counts and OUT OF RANGE lamp (5) will light when number of counts for inductance, capacitance or resistance is less than about 60 counts in parallel inductance (Lp), series capacitance (Cs) or parallel resistance (Rp) measurement modes. This condition does not occur when measurement mode is series inductance (Ls), parallel capacitance (Cp) or series resistance (Rs).

(5) OUT OF RANGE lamp: This lamp is turned on if inductance, capacitance, resistance or dissipation factor measured is out of the measurement range as determined by selected range when RANGE HOLD (9) is set to ON; and by selected CIRCUIT MODE (12) when RANGE HOLD (9) is OFF. When OUT OF RANGE lamp lights, either one or both displays will be blank or read 1999 counts.

(6) REMOTE lamp. When this lamp is on, it means that instrument is being remotely controlled by external devices connected to 4261A Option 003 or Opt on 101. Front panel FREQUENCY (17), Cp TEST SIG LEVEL (13), TRIGGER (10), FUNCTION (14), CIRCUIT MODE (12), and RANGE HOLD (9) controls are disabled when REMOTE lamp is lit.

Front Panel Features (Sheet 1 of 2).

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⑦ DISSIPATION FACTOR Display. Value for dissipation factor is always displayed as a decimal. Dissipation factor measurements in the range of 0.000 to 1.900 can be measured with meaning. Other dissipation factor values measured with the instrument do not have meaning. This display is blanked when making resistance measurements and when number of counts for inductance (Ls) or capacitance (Cp) is less than 80 counts.

⑧ MANUAL Trigger Pushbutton Switch. When this button switch is pushed and released, it triggers a measurement cycle. The switch is normally used when TRIGGER ⑩ is set to EXT, but it also functions when TRIGGER ⑩ is set to INT. A measurement cycle is initiated when the TRIGGER pushbutton is released. Holding the TRIGGER pushbutton in its depressed position holds the measurement. Releasing the button initiates a measurement and permits INT (internal) triggering to continue.

⑨ RANGE HOLD Switch. Setting this switch to OFF enables the instrument to make measurements in autoranging mode. When RANGE HOLD is set to ON, range is held on range selected just prior to setting RANGE HOLD to ON. When RANGE HOLD is in ON position, range is scaled down by one decade when changing test frequency from 120Hz to 1kHz and scaled up by one decade by changing from 1kHz to 120Hz except in resistance measurements.

⑩ TRIGGER Switch. This switch selects trigger mode, INT or EXT. INT trigger is internal trigger mode and enables instrument to make repeated automatic measurements. In external trigger (EXT) mode, triggering is performed by either operating MANUAL trigger button ⑧, by a trigger signal through EXT TRIGGER input connector on rear panel or by a remote control signal via rear REMOTE INPUT connector.

⑪ Instruction Card. This card provides simplified measurement procedures and outlines measurement ranges.

⑫ CIRCUIT MODE Selector Switch. Appropriate circuit mode for taking a measurement is selected and set with this switch. A parallel equivalent circuit is selected when the switch is set to PARA position and series equivalent circuit in the SER position. The instrument automatically selects the appropriate parallel or series equivalent in when set to AUTO circuit mode position. Measurement range for each position is shown in the Instruction Card ⑪.

⑬ Cp TEST SIG LEVEL selector switch. This switch is effective only in parallel capacitance measurements and permits selection of test voltage to be applied to sample (50mVrms or 1Vrms). The 50mV test voltage is generally utilized in semiconductor device measurements.

⑭ FUNCTION Switch. This switch selects electrical circuit parameter to be measured with the instrument as follows:

FUNCTION	Parameter(s) measured
L	inductance and dissipation factor
C	capacitance and dissipation factor
R	resistance

⑮ DC BIAS Selector Switch. This switch permits selection of internal DC bias voltage applied to sample (1.5Vdc, 2.2Vdc, or 6.0Vdc) or when switch is set to EXT, is used to apply external bias voltage from rear DC BIAS input connectors. OFF position is selected in no bias voltage is necessary.

⑯ UNKNOWN Terminals. Consists of four terminals: High current terminal (H_{CUR}), High potential terminal (H_{POTEN}), Low potential terminal (L_{POTEN}) and Low current terminal (L_{CUR}). The five-terminal configuration is constructed by adding the GUARD terminal ⑱. A three-terminal configuration is constructed by shorting High terminals and Low terminals together with shorting bars. The high terminals are biased with a positive DC voltage with respect to LOW terminals.

⑰ FREQUENCY Selector Switch. Permits selection of frequency of test signal applied to sample, either 120Hz or 1kHz.

⑱ GUARD Terminal. This is connected to chassis ground of instrument and can be used as Guard terminal for increasing accuracy in certain measurements.

Figure 3-1. Front Panel Features (Sheet 2 of 2).

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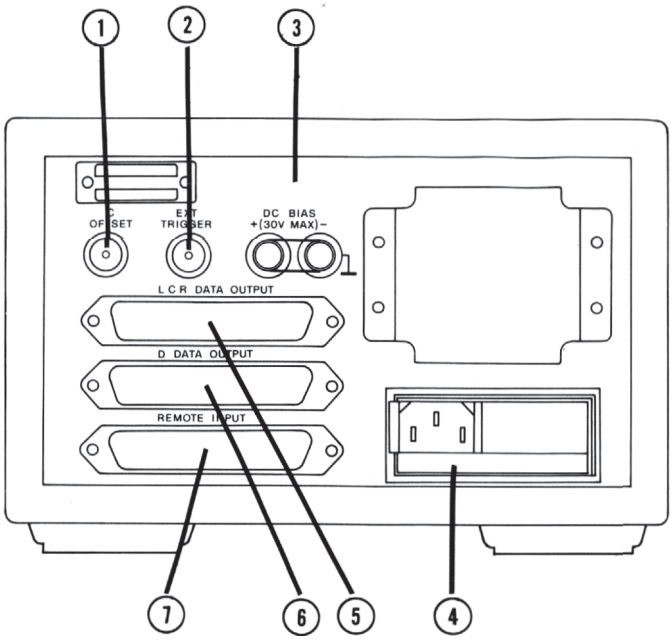

4261A REAR PANEL

(1) C OFFSET Signal Output Connector. A capacitance offset adjustment can be made by using the signal from this connector. In addition, the test voltage applied to sample can be monitored with an ac voltmeter or oscilloscope connected to this connector. DC bias voltage is not outputted from this connector.

(2) EXT TRIGGER Connector. This connector is used for external triggering the instrument by inputting a trigger signal from an external device including a user designed triggering circuit. For external triggering, TRIGGER switch on front panel is normally set to EXT position.

(3) DC BIAS Voltage Input Connectors. External DC bias voltage can be applied to the sample up to the maximum voltage of plus 30V through the connectors.

(4) AC Power Input Connector. Permits line voltage selection of 100Vac, 120Vac, 220Vac or 240Vac.

(5) LCR DATA OUTPUT Connector. With Option 001 BCD parallel data for inductance, capacitance and resistance measured values are outputted through this 50-pin connector. Option 002 adds dissipation factor output also in BCD parallel data form in serial with inductance or capacitance data (Option 001) from this connector.

(6) D DATA OUTPUT Connector. BCD parallel data of measured dissipation factor are outputted through this 50-pin connector (Option 001).

(7) REMOTE INPUT Connector. An External device can remotely control the instrument by inputting control signals through this 50-pin connector. Front panel controls for FREQUENCY, Cp TEST SIG LEVEL, FUNCTION, CIRCUIT MODE and Ranging can be controlled.

Figure 3-2. Rear Panel Features.

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Operating Check (Continued).

6. The two 4261A displays should indicate maximum counts when 4261A controls are set as follows:

4261A Settings	Display
FUNCTION ..... R CIRCUIT MODE ..... AUTO TRIGGER ..... INT UNKNOWN device .. Open (∞Ω)	Left display should read 19.99MΩ.
FUNCTION ..... L CIRCUIT MODE ..... PARA TRIGGER ..... INT UNKNOWN device .. Short (0Ω)	Right display should read 1.999.

7. Check that trigger lamp repeatedly turns on and off when 4261A TRIGGER is set to INT.

8. Measurement lamp unit display check. Measurement unit lamp displays should light sequentially when 4261A is operated as follows:

   1. Set 4261A to:

      FUNCTION ..... L, C or R
      CIRCUIT MODE ..... AUTO
      FREQUENCY 120Hz
      TRIGGER ..... EXT
      UNKNOWN device ..... Open (∞Ω)
      RANGE HOLD ..... OFF

   2. Push MANUAL button.

   3. Short High and Low terminals together.

   4. As MANUAL button is pushed and released unit display should sequentially change as follows:

FUNCTION	Unit Display
L	H → mH → μH
C	pF → nF → μF → mF
R	MΩ → kΩ → Ω → mΩ

9. The 4261A left display will read some minimum value in milliohms (typical value may be 006mΩ, for example) when unit is set to:

   FUNCTION ..... R
   CIRCUIT MODE ..... AUTO
   TRIGGER ..... INT
   RANGE HOLD ..... OFF
   UNKNOWN device ..... Short (0Ω)

10. Set RANGE HOLD to ON.

11. Check that left display unit maintains its previous mΩ display when UNKNOWN device terminals are opened (∞Ω).

12. OUT OF RANGE lamp should light if 4261A is set as follows:

    FUNCTION ..... R
    CIRCUIT MODE ..... AUTO
    TRIGGER ..... INT
    UNKNOWN device ..... Open (∞Ω)

Figure 3-3. Operating Check (Sheet 2 of 2).

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Table 3-1. Test Fixtures and Leads.

Accessory	Characteristics
16061A Test Fixture	This fixture facilitates easy measurement of general tubular type components with axial or vertical leads. To install fixture, disconnect shorting bars between high terminals and between low terminals. Insert fixture plugs into UNKNOWN terminals. Tighten fixture screws to firmly attach fixture to instrument. Two kinds of inserts are included (for components with either axial or vertical leads).
16062A Test Leads	These test-leads are especially useful for the measurement of low impedances (e.g., a low inductance - less than approx. 2H at 1kHz or 20H at 120Hz, a high capacitance - more than approx. 10nF at 1kHz or 100nF at 120Hz or a low resistance - less than approx. 10kΩ). If the measuring sample is more than approx. 300μF at 1kHz or less than approx. 100μH at 1kHz, it is recommended that the respective potential leads and current leads should be twisted together.
16063A Test Leads	These test-leads are particularly useful for measuring high impedances (e.g., an inductance of more than approx. 3mH at 1kHz or 30mH at 120Hz, a capacitance lower than approx. 10μF at 1kHz or 100μF at 120Hz, or a resistance more than approx. 20Ω). They are not intended to be used for accurate measurement of small capacitances less than approx. 100pF due to the residual capacitance of the leads.

The four-terminal measurement configuration is adopted for measurements of low series inductance (Ls), high series capacitance (Cs) or low series resistance (Rs) to eliminate the effect of residual impedance of measuring terminals and lead wires. The GUARD terminal is sometimes used to compensate for the effects of stray capacitance and leakage resistance existing between terminals and lead wires when measuring low capacitance or high inductance. Table 3-2 relates the instrument measuring circuit mode to the equivalent circuit and parameter terminology.

3-13. Parameter values for a component measured in a parallel equivalent circuit and that measured in series equivalent circuit are different from each other. For example, the parallel capacitance of a given component is not equal to the series capacitance of that component. Figure 3-4 shows the relationships between parallel and series parameters for various values of D. Applicable diagrams and equations are given in the chart. For example, a parallel capacitance (Cp) of 1000pF with a dissipation factor of 0.5, is equivalent to a series capacitance (Cs) value of 1250pF at 1kHz. As shown in Figure 3-4, inductance or capacitance values for parallel and series equivalents are almost identical when the dissipation factor is less than 0.01. The letter D in Figure 3-4 represents dissipation factor and is calculated by the equations presented in Table 3-3 for each circuit mode. The dissipation factor of a component always has the same dissipation factor at a given frequency for both parallel equivalent and series equivalent circuits.

Table 3-2. Parameter Terminology.

Circuit Mode	Equivalent Circuit	Terminology
Cp mode Rp mode		Cp: parallel capacitance Rp: parallel resistance
Cs mode		Cs: series capacitance Rs: series resistance
Lp mode		Lp: parallel inductance Rp: parallel resistance
Ls mode Rs mode		Ls: series inductance Rs: series resistance

Note

Dissipation factors displayed when CIRCUIT MODE is switched between PARA and SER may exhibit slight differences due to the measurement accuracy of the 4261A.

The reciprocal of the dissipation factor (D) is quality factor (Q) and D is often represented as tan δ which is the tangent of the dissipation angle (δ). Figure 3-5 is a graphical presentation of the equations in Table 3-3. For example, a series inductance of 1000μH which has a dissipation factor of 0.5 at 1kHz has a series resistance of 3.14 ohms.

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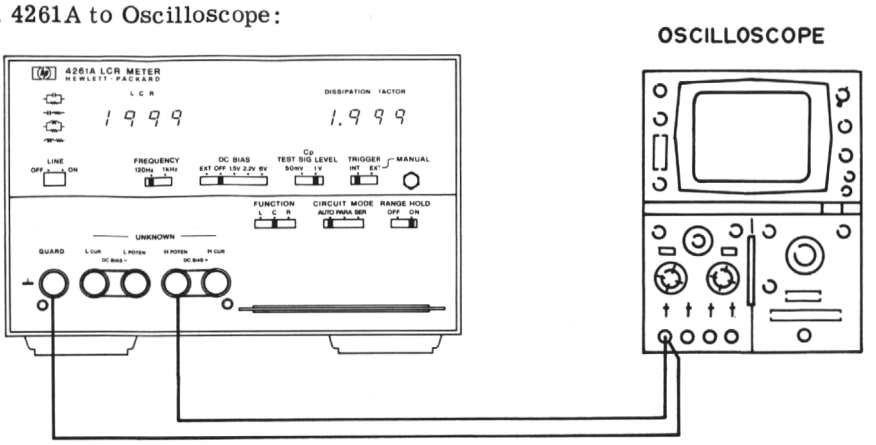
OPERATING CHECK

1. Connect 4261A to Oscilloscope:



2. Set 4261A to:

FUNCTION C
CIRCUIT MODE ..... PARA

3. Set oscilloscope and check operating frequencies, test signal levels and internal bias as follows:

Oscilloscope Settings	Frequency/Internal Bias Voltage
VOLTS/DIV: 0.05V TIME/DIV: 2msec DC input mode	Frequency displayed on oscilloscope should change as 4261A FREQUENCY control (120Hz & 1kHz) is changed. Signal level displayed on oscilloscope should change as 4261A Cp TEST SIG LEVEL control (50mV & 1V) is changed.
VOLTS/DIV: 0.2V TIME/DIV: 2msec DC input mode	DC level of test signal on oscilloscope should change as DC BIAS control is switched from 1.5V to 2.2V and 6V.

4. Disconnect oscilloscope.

5. Check that the circuit mode indicator lamp correctly lights when FUNCTION and CIRCUIT MODE switches are changed. Table shows FUNCTION and CIRCUIT MODE arrangement.

FUNCTION	CIRCUIT MODE	
	PARA	SER
L		
C		
R		

Figure 3-3. Operating Check (Sheet 1 of 2).

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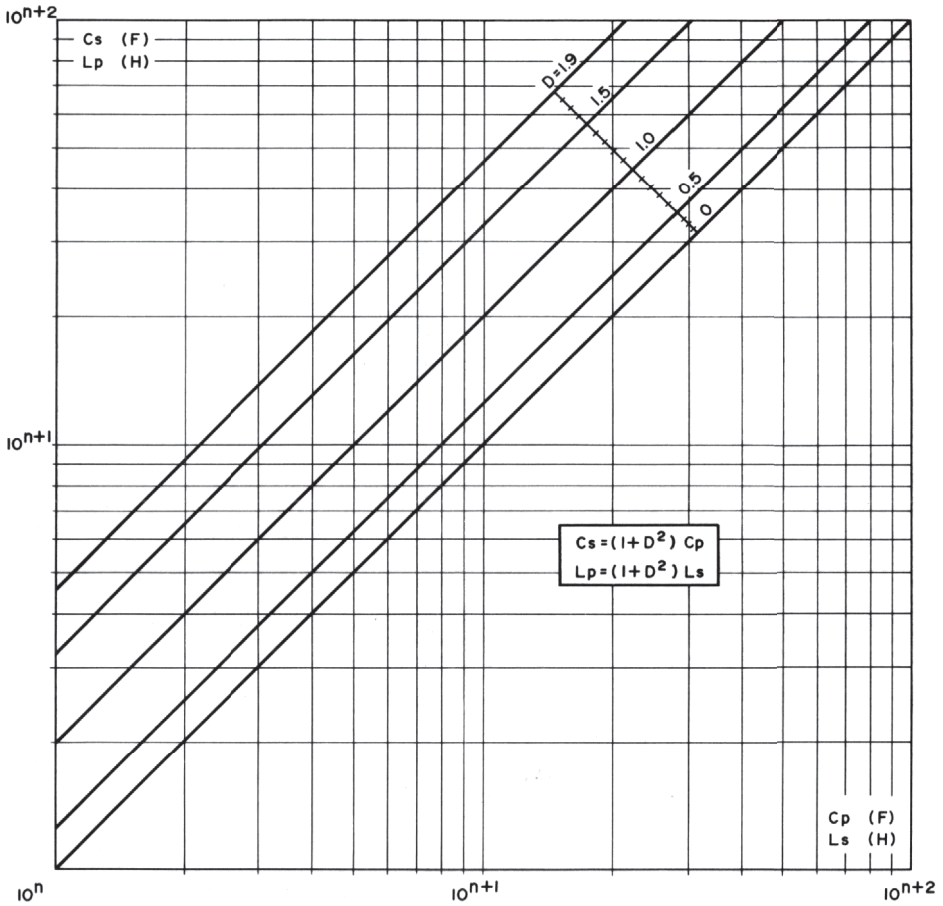
Table 3-3. Dissipation Factor Equations.

Circuit Mode		Dissipation Factor	Conversion to other modes
Cp mode		$D = \frac{1}{2\pi fCpRp} \left(= \frac{1}{Q}\right)$	$Cs = (1 + D^2)Cp,\ Rs = \frac{D^2}{1 + D^2} \cdot Rp$
Cs mode		$D = 2\pi fCsRs \left(= \frac{1}{Q}\right)$	$Cp = \frac{1}{1 + D^2} Cs,\ Rp = \frac{1 + D^2}{D^2} \cdot Rs$
Lp mode		$D = \frac{2\pi fLp}{Rp} \left(= \frac{1}{Q}\right)$	$Ls = \frac{1}{1 + D^2} Lp,\ Rs = \frac{D^2}{1 + D^2} \cdot Rp$
Ls mode		$D = \frac{Rs}{2\pi fLs} \left(= \frac{1}{Q}\right)$	$Lp = (1 + D^2)Ls,\ Rp = \frac{1 + D^2}{D^2} \cdot Rs$

*f: Test signal frequency.



Where n stands for a free integer.

Figure 3-4. Conversion Between Parallel and Series Equivalents.

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Table 3-4. Test Signal Level.

RANGE	CIRCUIT MODE					
	Ls	Lp	Cs	Cp	Rs	Rp
1	70mA rms	———	———	1V rms (50mV rms)*	70mA rms	———
2	10mA rms	———	———	1V rms (50mV rms)*	10mA rms	———
3	1mA rms	———	———	1V rms (50mV rms)*	1mA rms	———
4	100 μA rms	1V rms	10 μA rms	1V rms (50mV rms)*	100 μA rms	1V rms
5	10 μA rms	1V rms	100 μA rms	1V rms (50mV rms)*	10 μA rms	1V rms
6	———	1V rms	1 μA rms	———	———	1V rms
7	———	1V rms	10mA rms	———	———	1V rms
8	———	———	70mArms	———	———	1V rms

* When Cp TEST SIG LEVEL is set to 50mV.

3-14. Test Signals. Two test signal frequencies are available; these are 120Hz and 1kHz sinusoidal waveforms which have a frequency accuracy of 3%. The typical voltage applied to the sample or current flowing thourh the sample is specified in Table 3-4 for both test signal frequencies. A constant test voltage is supplied to the sample when measuring parallel parameters Lp, Cp and Rp. The constant current method is adopted for the measurement of Ls, Cs and Rs. The 50mV rms test voltage is available only for Cp measurement.

Note

Voltage or current applied to sample is detailed in Table 1-2 for the various devices under test.

3-15. Measurement Range. The 4261A has wide measurement ranges as shown in Table 3-5. Seven or eight ranges are available (depending upon measurement function) and the range is automatically selected for the sample value connected to the 4261A. Four or five ranges, however, are used for measurements in series and parallel equivalent circuit modes. When the CIRCUIT MODE is set to AUTO, the 4261A will automatically select the circuit mode, range over all the measurement ranges shadowed in Table 3-5, and measure the sample. An instruction card attached to the instrument also outlines all measurement ranges.

3-16. Display. The 4261A has two displays, the LCR display (left side) and the DISSIPATION FACTOR display (right side). The circuit mode indicator lamp

Table 3-5. Measurement Ranges.

CKT MODE	FREQUENCY	RANGE							
		1	2	3	4	5	6	7	8
Lp	120 Hz				0000mH	00.00 H	000.0 H	0000H	
	1kHz				000.0mH	0000mH	00.00 H	000.0 H	
Ls	120Hz	0000μH	00.00mH	000.0mH	0000mH	00.00 H			
	1kHz	000.0μH	0000μH	00.00mH	000.0mH	0000mH			
Cp	120Hz	0000pF	00.00nF	000.0nF	0000nF	00.00μF			
	1kHz	000.0pF	0000pF	00.00nF	000.0nF	0000nF			
Cs	120Hz				0000nF	00.00μF	000.0μF	0000μF	00.00mF
	1kHz				000.0nF	0000nF	00.00μF	000.0μF	0000MF
Rp	120Hz				0000Ω	00.00kΩ	000.0kΩ	0000kΩ	00.00MΩ
	1kHz				0000Ω	00.00kΩ	000.0kΩ	0000kΩ	00.00MΩ
Rs	120Hz	0000mΩ	00.00Ω	000.0Ω	0000Ω	00.00kΩ			
	1kHz	0000mΩ	00.00Ω	000.0Ω	0000Ω	00.00kΩ			

Note: 0000μH indicates a range of 0001μH to 1900μH (and similarly for F and Ω).

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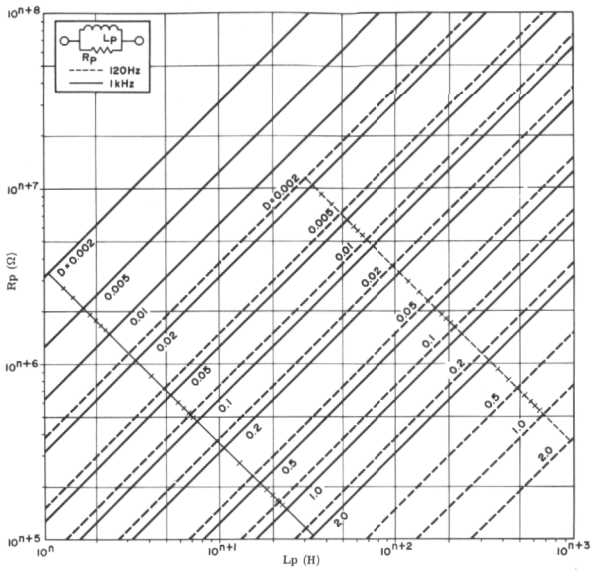
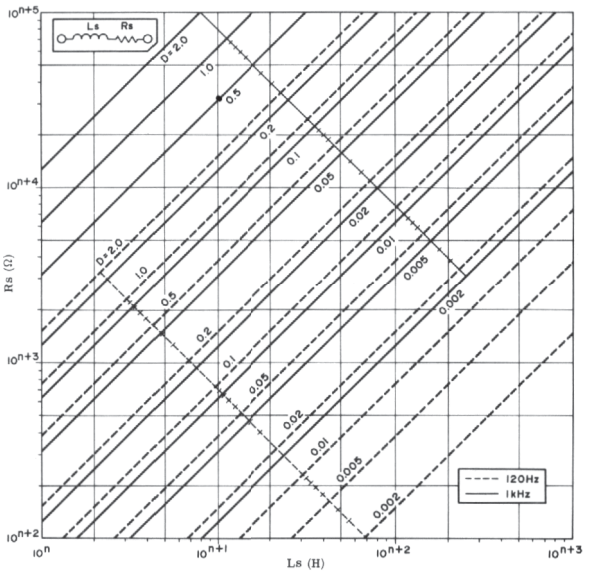
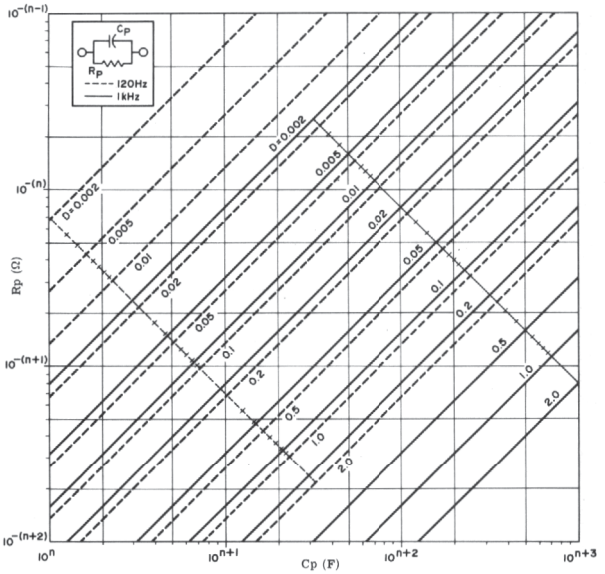


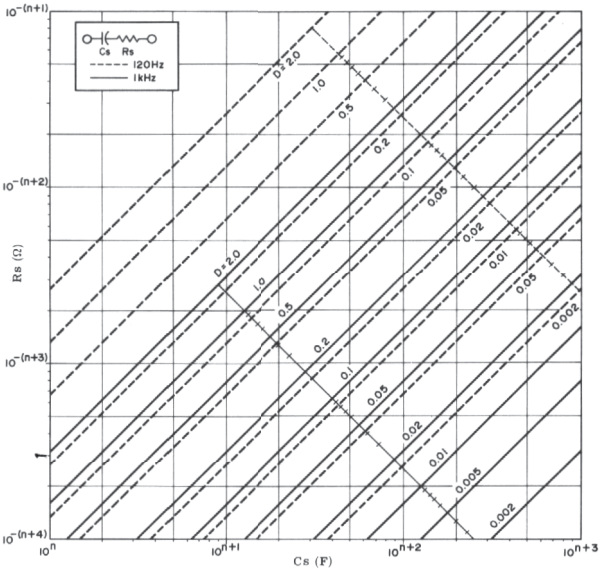
Parallel Inductance - Parallel Resistance
(A)



Series Inductance - Series Resistance
(B)



Parallel Capacitance - Parallel Resistance
(C)



Series Capacitance - Series Resistance
(D)

When n represents a free integer.

Figure 3-5. Relationship of Dissipation to Series and Parallel Resistance.

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is lit as assigned by the settings of FUNCTION and CIRCUIT MODE. The unit lamps light and are read in conjunction with the numerical LCR display to their left. The right side display is blanked during resistance measurement. Table 3-6 describes operator action to be taken when OUT OF RANGE lamp is lit, when the display is blanked, or when a minus display occurs.

Note

LCR display is meaningful even if D diaplay shows 1999 counts and OUT OF RANGE lamp lights. However, measurement error will increase in proportion to increase in D value. See Table 1-2 for details.

CAUTION

DISSIPATION FACTOR DISPLAY SOMETIMES RANDOMLY DISPLAYS A MEASUREMENT OR A BLANK CONDITION WHEN VALUE OF CAPACITANCE OR INDUCTANCE IS AROUND 80 COUNTS ON MINIMUM MEASUREABLE RANGE AT ANY PANEL CONTROL SETTING.

3-17. Accuracy. Figure 3-6 is a graphic representation of the accuracy specifications provided in Table 1-1. The horizontal axis for all curves is the reading of the 4261A in counts and the vertical axis

Table 3-6. Annunciation Display Meanings.

Display	Indicated Condition	Action
OUT OF RANGE	1. At least one of two displays exceeds 1999 counts (in this case, at least one display shows 1999 counts).	a. Set 4261A to: CIRCUIT MODE: AUTO RANGE HOLD: OFF FREQUENCY: 120Hz b. Try changing FUNCTION to L, C or R.
	2. Measured value for Lp, Cs or Rp is less than about 80 counts. Both displays show 1999 counts. In Rp mode, right display is always being blanked.	
	3. Range is held to one not specified as a measurable range for parallel or series circuit modes. When this occurs, numerals (only) of both displays are blanked. Decimal point is still lit.	
Display is blanked.	1. Right display (only) is blanked during Rp or Rs measurement.	Normal operation.
	2. Range is held to one not specified as measurable range for parallel or series circuit mode. OUT OF RANGE lamp is also lit.	a. Set 4261A to: CIRCUIT MODE: AUTO RANGE HOLD: OFF FREQUENCY: 120Hz b. Check that FUNCTION is correct.
	3. Right display (only) is blanked when measured value of inductance (Ls) or capacitance (Cp) is less than 80 counts.	
	4. Right display (only) is blanked when Lp or Cs value exceeds 1999 counts. In this case, OUT OF RANGE lamp is lit.	
Minus (-) is displayed.	1. Minus display sometimes occurs when sample having a value around zero is measured.	Zero counts display is meaningful when minus (-) display repeatedly turns on and off.
	2. Sometimes a minus display occurs when a capacitor (or inductor) is measured in L (or C) FUNCTION.	Change to correct FUNCTION.
	3. Offset adjustment signal applied is too great (causes minus display).	Readjust offset signal to proper magnitude.

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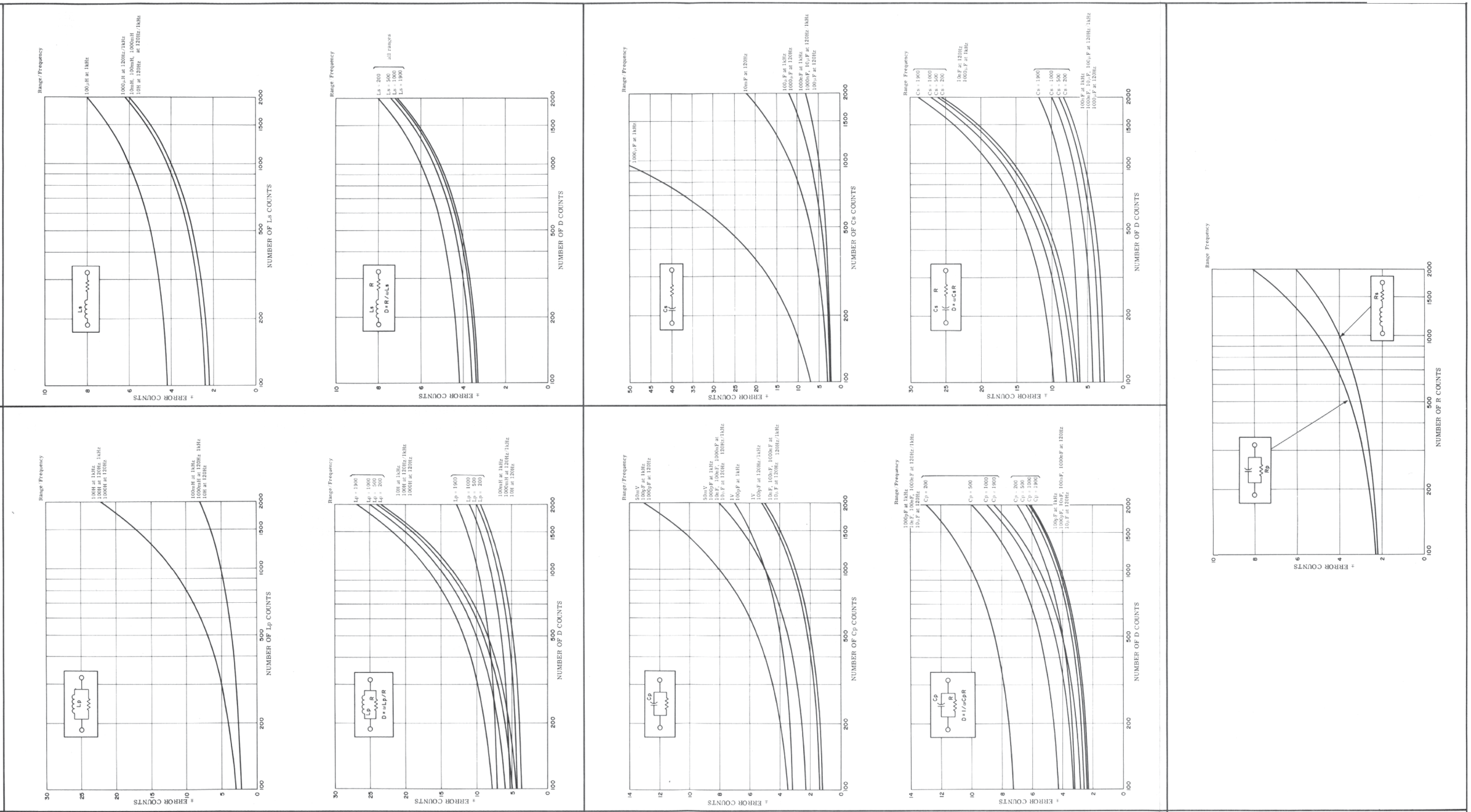

Figure 3-6. Accuracy.

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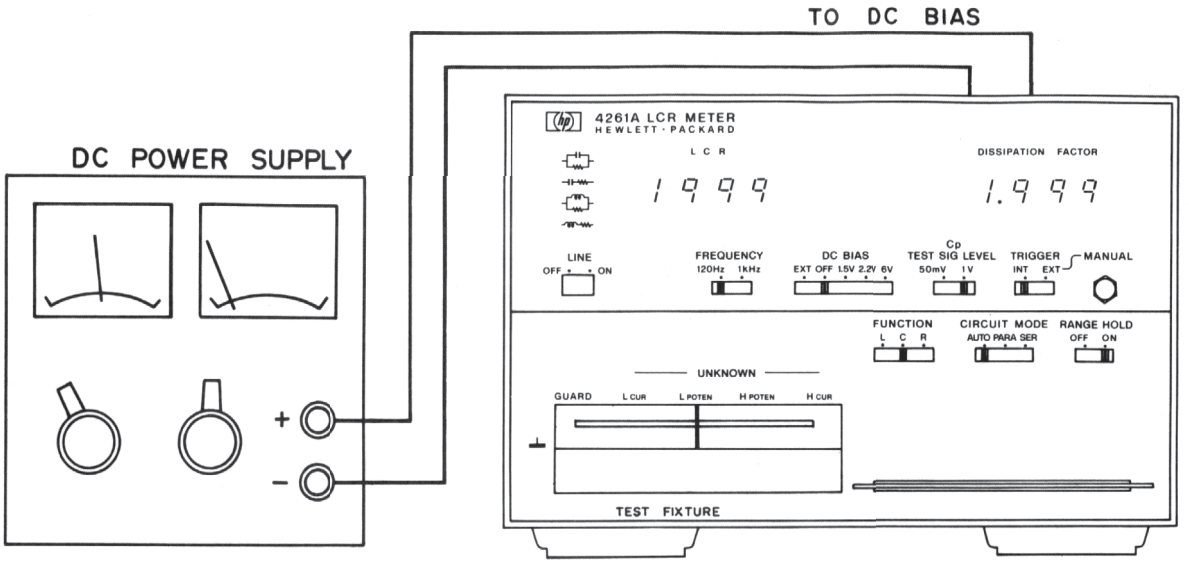

1. Remove shorting bar connections between high terminals and between low terminals (all terminals are now isolated from each other). Connect 16061A Test Fixture to 4261A UNKNOWN terminals.

Note

User constructed test fixture may also be connected as stray capacitance of test fixture connection can be compensated for by using C OFFSET signal from rear connector. Refer to Figure 3-10 for details. GUARD terminal is sometimes used in small capacitance measurements. Refer to paragraph 3-9 for details.

2. Set 4261A controls as follows:

FREQUENCY ..... 120Hz or 1kHz
DC BIAS ..... OFF
Cp TEST SIG LEVEL 1V
TRIGGER ..... INT
FUNCTION ..... L, C or R
CIRCUIT MODE ..... AUTO
RANGE HOLD ..... OFF

Note

If manual triggering is required, TRIGGER switch is set to EXT position and MANUAL button pushed and released to trigger measurement. In Cp mode, Cp TEST SIG LEVEL may be set to 1V for a more accurate measurement than that with 50mV test level.

3. Push LINE to turn instrument ON. Check that trigger lamp turns on and off.

Figure 3-7. General Component Measurements (Sheet 1 of 2).

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4. Connect sample to be measured (L, C or R) to Test Fixture.

Note

When OUT OF RANGE, minus (-) or blank display occurs, see Table 3-6 for solution. Measured values for semiconductor devices are sometimes unreliable when Cp TEST SIG LEVEL is set to 1V position. In these instances, follow Figure 3-8 for semiconductor device measurement.

5. If internal DC bias is required, set DC BIAS switch to 1.5V, 2.2V or 6V. If not, OFF position should be selected.

Note

DC bias application may only be used for capacitance measurements.

CAUTION

POSITIVE POLE OF ELECTROLYTIC CAPACITOR MUST BE CONNECTED TO HIGH TERMINALS AS PLUS BIAS VOLTAGE IS APPLIED TO HIGH TERMINALS WITH RESPECT TO LOW TERMINALS.

Note

An external bias voltage up to +30V may be applied to EXT BIAS rear panel connector. Connect DC power supply to EXT BIAS connectors. Set DC BIAS switch to EXT.

CAUTION

EXTERNAL DC BIAS THROUGH EXT BIAS CONNECTOR MUST NEVER EXCEED +30V.

6. Read measured value on display. Refer to Figure 3-6 for accuracy of reading.

Note

It is usually best to set RANGE HOLD switch to ON when measuring multiple samples having almost the same value.

Note

Series resistance of electrolytic capacitors, inductors or transformers can be measured in Rs measurement mode. In these cases, the number of digits is sometimes reduced. On the other hand, resistance can, of course, be indirectly measured with the C/L FUNCTION and calculated from one of the following equations:

$$Rs = D/\omega Cs \quad \text{(Cs-D measurement)}$$
$$Rs = \omega Ls \cdot D \quad \text{(Ls-D measurement)}$$
$$Rs = \omega Lp \cdot \frac{D}{1+D^2} \quad \text{(Lp-D measurement)}$$

Figure 3-7. General Component Measurements (Sheet 2 of 2).

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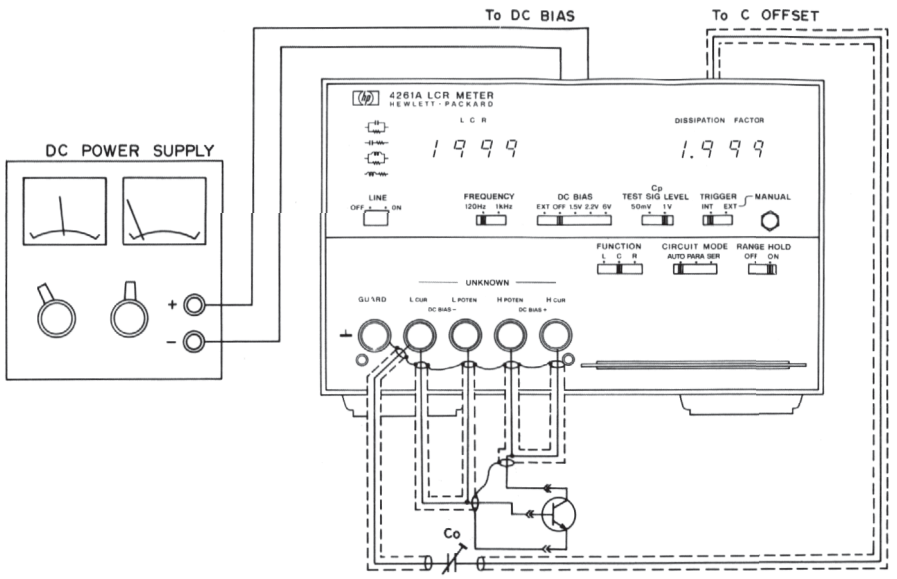

Note

Base-collector junction capacitance of NPN transistor may be measured using the test setup shown in this figure (for example).

1. Construct setup as shown above:

Note

Test leads or fixture may be user designed for this measurement. If external DC bias is not necessary or capacitance offset adjustment function is not needed, arrangement and procedures associated with these functions can be deleted from setup.

2. Set 4261A controls as follows:

FREQUENCY	1kHz
DC BIAS	OFF
Cp TEST SIG LEVEL	50mV
TRIGGER	INT
FUNCTION	C
CIRCUIT MODE	PARA
RANGE HOLD	OFF

CAUTION

CIRCUIT MODE SHOULD NOT BE SET TO AUTO OR SER.
Cp TEST SIG LEVEL MUST BE IN 50mV.

3. Push LINE to turn instrument ON. Verify that trigger lamp is turning on and off.

4. If necessary, apply DC bias voltage internally or externally at rear panel DC BIAS connectors.

CAUTION

NEVER APPLY AN EXTERNAL DC BIAS OVER +30V.

Figure 3-8. Semiconductor Device Measurements (Sheet 1 of 2).

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Notes

a. DC BIAS switch must be in EXT position during application of external DC BIAS at rear panel connectors.

b. External dc bias source should be stable with low noise.

5. Adjust capacitance offset adjustment pot (Co) for zero capacitance reading. See Figure 3-10 for details.

6. Connect semiconductor device to test lead or to fixture. The following are examples of connections for the various parameters to be measured:

Notes

a. It is impossible to measure junction capacitance when bias current flows through sample.

b. It is recommended that the device be connected directly to 4261A terminals. If test cable is used, it should be shielded.

c. Set TRIGGER switch to EXT and use MANUAL switch for manual triggering. External trigger at rear panel connector may also be used. See Figure 3-11 for reference. It is recommended that RANGE HOLD be set to ON when measuring multiple samples whose values are about the same.

7. Read displayed values. Refer to Figure 3-6 for accuracy.

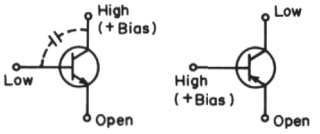
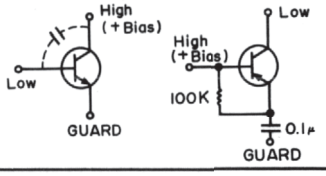
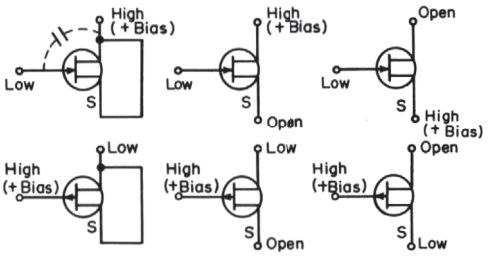
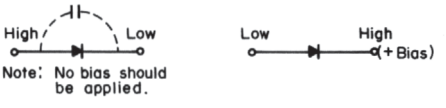
Parameter Measured	Connections to 4261A
Base-collector junction capacitance (Cob)- Emitter current = 0	
Base- collector junction capacitance (Cre)- Common emitter	
FET gate capacitance	
Diode junction capacitance Note: Germanium diodes sometimes cannot be measured.	

Figure 3-8. Semiconductor Device Measurements (Sheet 2 of 2).

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External DC Voltage Bias Circuits (30V < , < 200V)

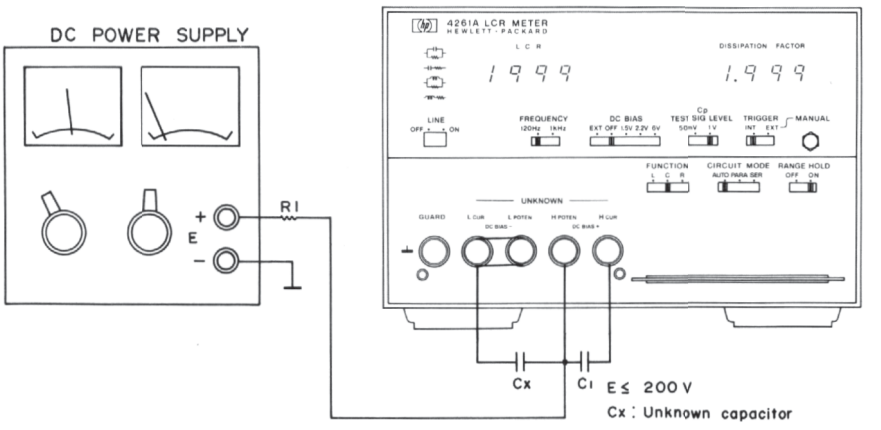
1. Connect external dc bias source as shown in diagram:

CAUTION

DO NOT APPLY DC VOLTAGE EXCEEDING 200 VOLTS. IF APPLIED, 4261A CIRCUITRY WILL BE DAMAGED.

Note

+E voltage is applied to Cx in figure. -E voltage can be applied to Cx in this figure. In this arrangement, the polarity of Cx and C1 must be taken into consideration.



CAUTION

NEVER SHORT BETWEEN H_{POTEN} AND LOW TERMINALS WHEN R_1 IS SMALLER THAN 1kΩ. IT IS BETTER TO MAKE SURE THAT UNKNOWN CAPACITOR IS NOT DEFECTIVE BEFORE CONNECTING TO INSTRUMENT.

Note

Ripple or noise on external dc bias source should be as low as possible. The low frequency noise of bias source should be less than 1mVrms for a Cp TEST SIG LEVEL of 50mV and 30mVrms for 1V.

2. Minimum values for C1 (dc blocking capacitor) and minimum values R1 are given in table below:

Note

Insulation resistance for Cx must be greater than a certain value. Refer to Table 3-7, page 3-23 of Unusual Operating Indications.

Range	120Hz	1000pF	10.00nF	100.0nF	1000nF	10.00μF
	1kHz	100.0pF	1000pF	10.00nF	100.0nF	1000nF
Minimum C_1(F)	120Hz	0.01μF	0.1μF	1μF	10μF	100μF
	1kHz	0.01μF	0.01μF	0.1μF	1μF	10μF
Minimum R_1 (Ω)		300kΩ	100kΩ	10kΩ	1kΩ	100Ω

Figure 3-9. External DC Bias Circuits (Sheet 1 of 3).

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Note

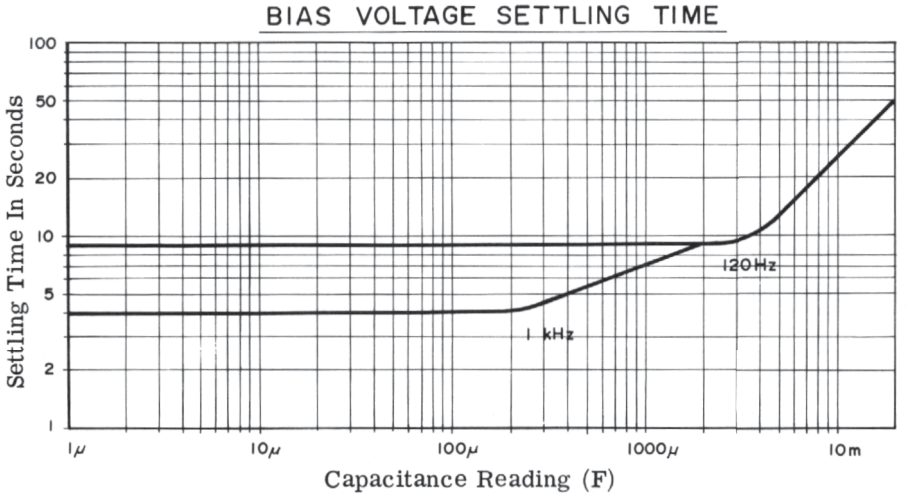
DC withstand voltage for C_1 capacitor must be greater than dc applied voltage E. Also observe polarity of capacitor C_1 with respect to applied voltage.

3. Set 4261A controls as follows:

FUNCTION C
CIRCUIT MODE ..... PARA
DC BIAS ..... OFF
Other controls ..... any setting

4. Read displayed value after allowing time for bias voltage to settle. Typical settling times are:

120Hz: 6 to 7 seconds.
1kHz: 2 to 3 seconds.



Note

If C_1 and R1 are larger than those given in table on Sheet 1 are connected, longer settling times are necessary.

USING CURRENT BIAS (for inductors).

1. Connect dc power supply as shown below:

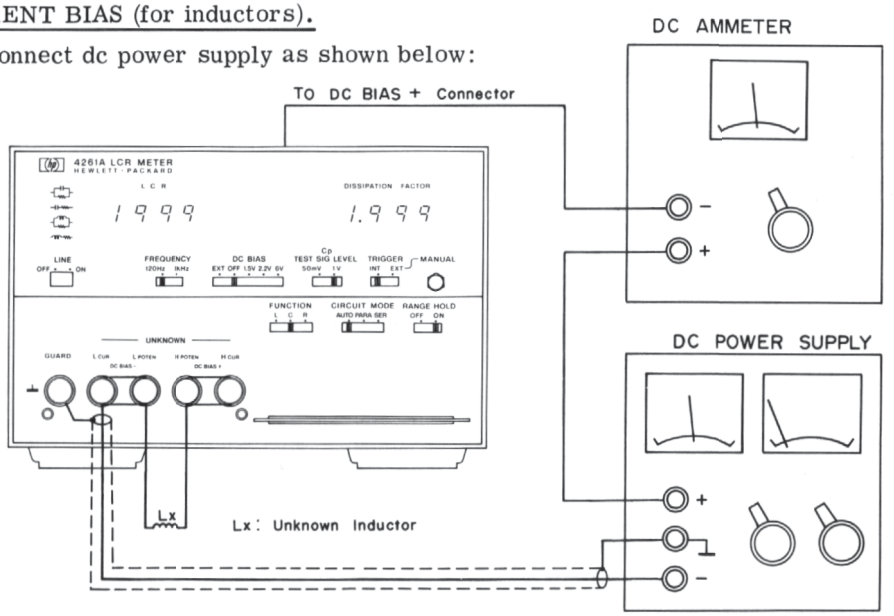


Figure 3-9. External DC Bias Circuits (Sheet 2 of 3).

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Note

DC power supply should be floated from ground.

Note

If cable between low terminals of 4261A and power supply is relatively long, it should be shielded cable. The outer conductor is connected to GUARD terminal.

2. Set 4261A as follows:

FREQUENCY .....120Hz or 1kHz
DC BIAS ..... EXT
FUNCTION L
CIRCUIT MODE ..... PARA or SER
RANGE HOLD ..... ON

Note

First, set RANGE HOLD set to OFF and determine range by connecting sample with no dc bias current applied. Then set RANGE HOLD to ON.

3. Recommended inductance ranges and maximum bias currents are:

RANGE	120Hz	1000μH	10.00mH	100.0mH	1000mH	10.00H	100.0H
	1kHz	100.0μH	1000μH	10.00mH	100.0mH	1000mH	10.00H
CIRCUIT MODE		SER			PARA		
Maximum Bias Current*		52mA	40mA	13mA	42mA	40mA	13mA

* Bias current when +30V is applied to DC BIAS connector.

CAUTION

DC BIAS OVER +30 VOLTS MUST NOT BE APPLIED TO EXTERNAL DC BIAS INPUT CONNECTOR.

Figure 3-9. External DC Bias Circuits (Sheet 3 of 3).

is the number of error counts which are added to or subtracted from the readings.

3-18. General Component Measurement.

3-19. Figure 3-7 shows the operating procedures for measuring an L, C or R (inductance, capacitance or resistance) circuit component. Almost all discrete circuit components (inductors, capacitors or resistors) except for components having special shapes or dimensions can be measured with this setup. Special components may be measured by using Test Leads 16062A and 16063A or by specially designed user built fixtures instead of 16061A Test Fixture. Although both external dc bias and capacitance offset adjustment can be used with the setup shown in Figure 3-7 by connecting a DC bias source and by using the C OFFSET signal, the two functions are not covered in this procedure. For these applications refer to Figures 3-9 or 3-10.

3-20. Semiconductor Device Measurement.

3-21. The procedures for using the 4261A semiconductor device measurement capabilities are described in Figure 3-8. For example, the junction (interterminal) capacitance of diodes, collector output capacitance of transistors, etc., can easily and accurately be measured (with and without dc bias).

3-22. External DC Bias.

3-23. A special biasing circuit using external voltage or current bias, as needed for capacitor or inductor measurements, is illustrated in Figure 3-9. The figure shows sample circuitry appropriate to 4261A applications. The biasing circuits avoid permitting dc current to flow into the 4261A as dc current increase the measurement error and because the excess current sometimes may cause damage to the instrument. When applying a dc voltage to capacitors, be sure applied voltage does not exceed maximum working voltage and that you are observing

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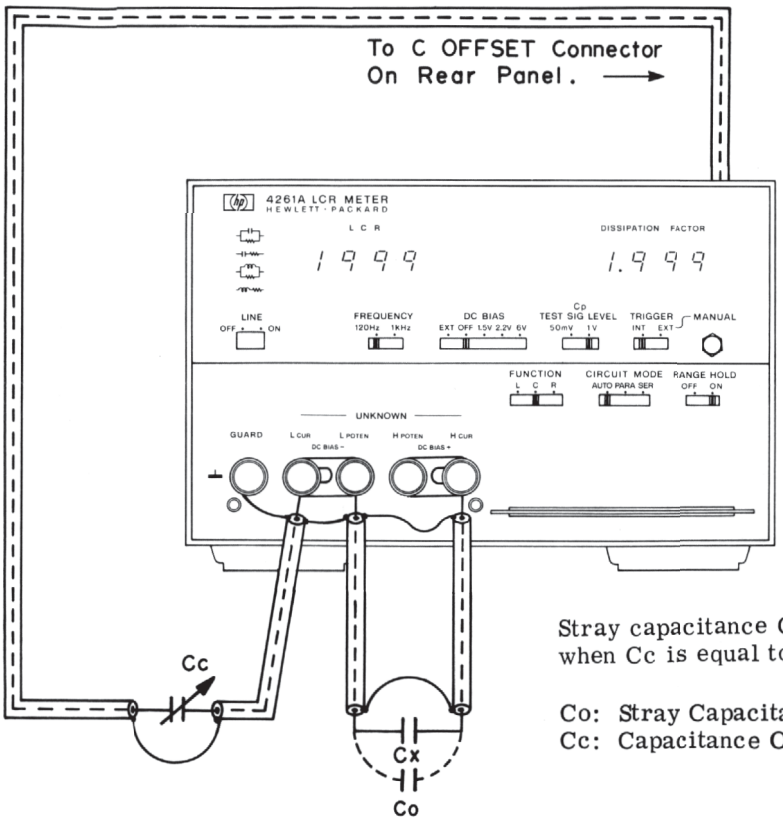

Procedure:

1. Connect signal from C OFFSET connector through a variable capacitor Cc to 4261A Low UNKNOWN terminals.

Notes

a. An air capacitor is recommended for capacitor (Cc). If unavailable, other low loss capacitors may be used. Reading error for D display will be increased if a lossy capacitor is used.

b. It is recommended that connection between Cc and Low terminal be made with a shielded cable to eliminate the effects of noise.

2. Adjust Cc so that a display of 000 is obtained on LCR DISPLAY when no unknown capacitor is connected to UNKNOWN terminals.

Notes

a. Compensation for stray capacitance is 0 to 100pF. Actual value of compensation realized depends upon method of connection and residual value of variable compensating capacitor (see Cc in above figure). Lowest actual compensating capacity achievable is typically on the order of a few pico-farads.

b. A display of -000 (minus) should be avoided when adjusting compensation. Adjust for 000 display.

Figure 3-10. C OFFSET Adjustment Setup.

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polarity of capacitor. Note that the external bias voltage is present at H_{CUR} and H_{POTEN} terminals.

3-24. Bias Voltage Settling Time. When a measurement with dc bias voltage superposed is performed, it takes some time for voltage across sample to reach a certain percentage of applied (desired) voltage. Figure 3-9 shows time for dc bias voltage to reach more than 99% of applied voltage and for 4261A to display a stable value. If the bias voltage across sample is not given sufficient time to settle, the displayed value may fluctuate or 1999 counts may be displayed and OUT OF RANGE lamp may light. Read measured value after display settles.

3-25. Offset Adjustments.

3-26. One of the sophisticated capabilities of the 4261A is its offset adjustment control which permits a direct, accurate display of actual measured value of sample by compensating for stray capacitance. Figure 3-10 shows recommended offset adjustment circuit and adjustment reange for capacitance measurements.

3-27. External Trigger Circuit.

3-28. Figure 3-11 illustrates an example of a trigger circuit device for triggering the 4261A externally via the external triggering connector on the 4261A rear panel. In addition, both manual trigger (by MANUAL pushbutton) and electronic trigger (by TTL level trigger circuit) are also useable. The unit is set for manual triggering by switching TRIGGER switch from INT to EXT (manual) position. In the EXT trigger mode, the 4261A may be triggered by a TTL level signal that is transmitted from low (+0V) to high (+5V) state by an external trigger circuit. Since all trigger signals, both internal and external (BNC on rear panel), are parallel connected in the 4261A, all triggers are always effective.

3-29. Operating Cautions.

3-30. Under some measurement conditions, the 4261A LCR Meter may occasionally show a display or exhibit a phenomena seems to indicate that the 4261A is faulty. These unusual displays and phenomena usually occur when the characteristics of the measured sample, residual impedance or stray conductance of the test fixture or test leads, and the measurement theory of the 4261A accumulate to produce these effects. Some of these conditions are inherent in the 4261A measurement scheme but most are not. Be sure to refer to Table 3-7 which outlines these indications their causes and countermeasures.

3-31. OPTIONAL OPERATION.

3-32. Installation information for options 001, 002, 003 and 101 is covered in Section II of this manual. Control signal timing and output data signal information with designators and pin connections for optional rear connectors are described in Section VIII (Service Sheet).

3-33. BCD Parallel Data Output (Option 001).

3-34. The 4261A option 001 outputs BCD L/C/R and D data, respectively, from two rear connectors in a parallel data scheme. In addition to L/C/R/D information, equivalent circuit mode, range, frequency, annunciation, and polarity data are simultaneously outputted. Figure 3-12 lists data outputted through the connector. Since the data from D DATA OUTPUT connector (when 4261A FUNCTION is set to R) has

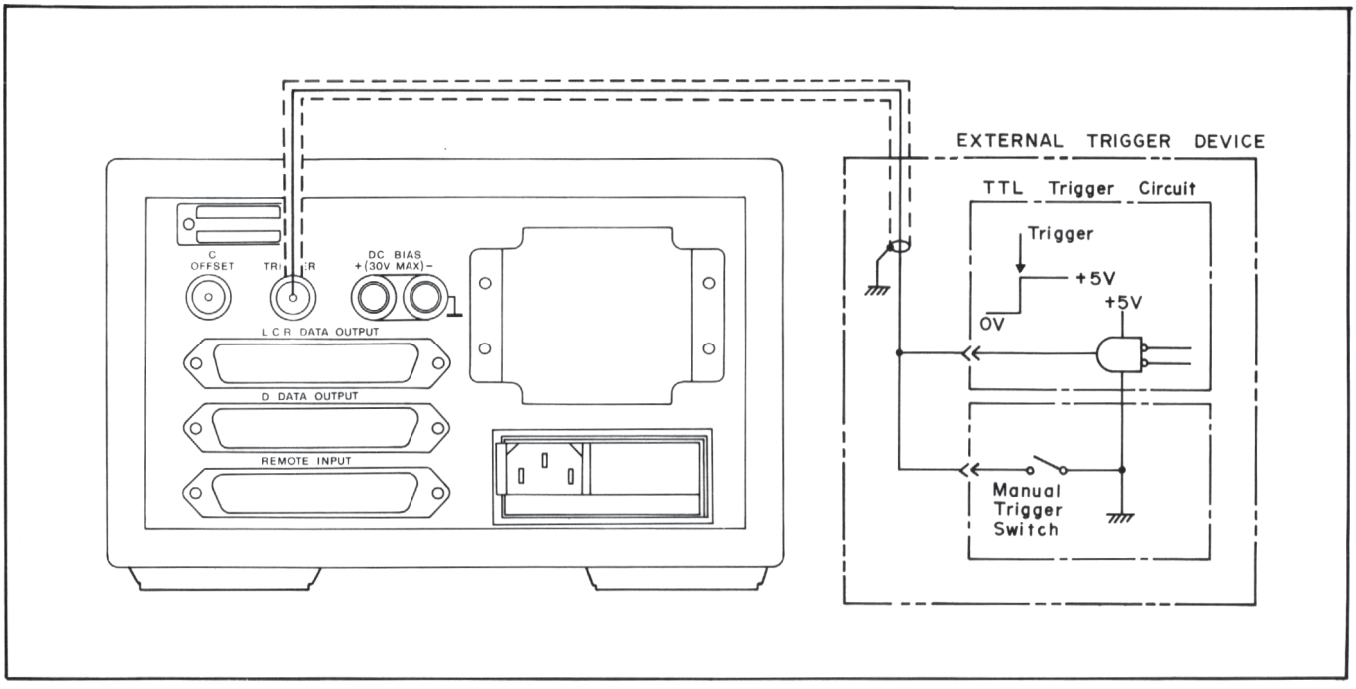

Figure 3-11. External Trigger Circuits.

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Table 3-7. Unusual Operating Indications (Sheet 1 of 3).

1. Indication: A. Same sample sometimes shows quite different values between PARA and SER CIRCUIT MODE measurements. B. The decimal point moves and measurement unit changes. A and/or B may occur in the following cases.

   Resistance of low loss inductor or capacitor being measured in R FUNCTION.

   Inductance of lossy inductor or capacitance for lossy capacitor being measured in L or C FUNCTION.

   What to do: A. Do not set CIRCUIT MODE to AUTO. Set CIRCUIT MODE to a PARA or SER setting that shows a valid display. B. Set TRIGGER to EXT, push MANUAL button, set RANGE HOLD to ON and set TRIGGER to INT.

2. Indication: The displayed value fluctuates on minimum capacitance, maximum inductance or maximum resistance ranges in either PARA or SER circuit modes. Here are some of the reasons why this happens:

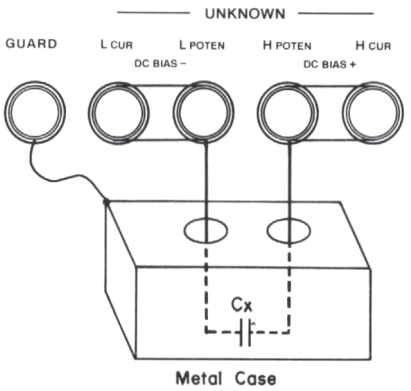
   A . A large size sample is being measured.

   B . A high voltage power line or similar exists near the 4261A.

   C . The 4261A and sample are connected together with relatively long, non-shielded cable.

   What to do:

   1. Enclose sample in metal case. Connect case electrically to 4261A GUARD terminal as shown below:



   2. Use shielded cable for connection between sample and the instrument. Connect cable shield to GUARD. For reference, see also Figure 3-8 (sheet 1) page 3-14.

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Table 3-7. Unusual Operating Indications (Sheet 2 of 3).

3. Indication: When measuring a low impedance (small inductance, resistance or high capacitance), measurement error is excessive.

What to do:

Cause of error	Action
1. Residual impedance (inductance, capacitance or resistance) of test leads during two terminal measurements. 2. Mutual test lead induction between current leads (H_{CUR} and L_{CUR}) and potential leads (H_{POTEN} and L_{POTEN}).	Use test leads in four-terminal configuration and measure. Twist current leads (H_{CUR} and L_{CUR}) together. Do the same with potential leads (H_{POTEN} and L_{POTEN}). Additional error is presented as ω^2LrCx X 100 (%) for C measurement, where: ω = 2πf f = test frequency Lr = residual inductance Cx = unknown capacitance

4. Indication: Measurement error is excessive when high impedance (high inductance, small capacitance) is measured:

What to do:

Measurement	Cause of error	Action
High Inductance	Stray capacitance between High and Low leads.	Use shielded cable for connection between sample and 4261A UNKNOWN terminals. Connect outer conductor to GUARD terminal.
Small Capacitance	Stray capacitance between High and Low leads.	Measure stray capacitance and subtract it from measured value.

5. Indication: Excessive measurement error.

What to do: Cause A . Effect of Low terminal capacitance with respect to ground. Sometimes the measurement can not be performed when a relatively large capacitance between L_{POTEN} terminal and ground exists. Allowable magnitude for the stray capacitance without additional error are:

Measurement Frequency	Allowable Stray Capacitance Magnitude
120Hz	100nF
1kHz	1000pF

Cause B . Effect of High terminal capacitance with respect to ground. The stray capacitance will reduce test signal level applied to the sample measured during capacitance measurement. This decrease in signal level will not produce an additional error even when measurement signal level is reduced to a third of its nominal level. It is neccessary, of course, that special care be taken to use the proper test signal level when a device is measured whose parameters may be affected by the test signal level. Display fluctuations may sometimes appear.

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Table 3-7. Unusual Operating Indications (Sheet 3 of 3).

6. Indication: When a sample (for example, an iron core inductor) is measured in AUTO of CIRCUIT MODE, the instrument repeats range selection and does not complete the measurement depending upon level of test current used.

What to do: Try to determine the range (test current level) that measures that sample properly by repeating ON and OFF RANGE HOLD operation several times. Must operate in Range HOLD mode for these cases.

7. Indication: When a capacitor is measured with dc bias voltage applied, an abnormal display occurs.

What to do: There are limitations to the permissible insulation resistance of a capacitor measured with dc bias. See below:

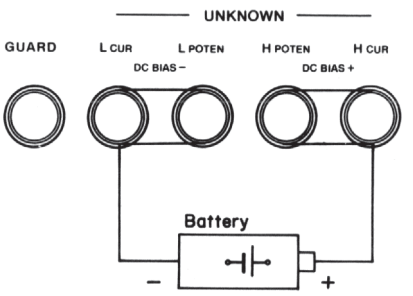
MODE		RANGE				
Cp	120Hz	1000pF	10.00nF	100.0nF	1000nF	10.00μF
	1kHz	100.0pF	1000pF	10.00nF	100.0nF	1000nF
Cs	120Hz	1000nF	10.00μF	100.0μF	1000μF	10.00mF
	1kHz	100.0nF	1000nF	10.00μF	100.0μF	1000μF
Permissible insulation resistance (Ri)		22.5MΩ	2250kΩ	225kΩ	22.5kΩ	2250Ω

Note: Ri given in above table is applicable for a dc bias of 30V. When the bias voltage is less than 30V, Ri limit is RiVb/30 (Ω) where Ri is value given in the table and Vb is applied dc bias voltage.

8. Indication: Internal resistance of a battery can not be measured.

What to do:

1. Connect sample battery (observe polarity) as illustrated below:



2. Batteries up to 30V are measured under no load conditions.

3. If battery voltage exceeds 4V, set DC BIAS to EXT and disconnect shorting bar from EXT DC BIAS connectors on rear panel.

4. Since the internal resistance of a battery is relatively very low, use the four-terminal measurement configuration.

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no meaning, this connector should not be used. Figure 3-13 is the printer print format with the meaning of printed data shown. Here is an example of how to read the printed output:

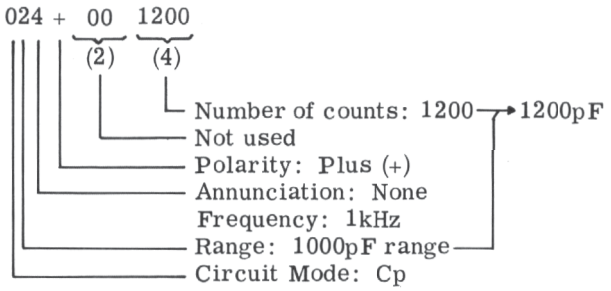


Figure 3-14 shows connections between the 4261A option 001 and HP devices. Model 4261A operation with option 001 follows standard operations described in Figure 3-7 and 3-8 except for connection of external devices. Operating information for HP printers is covered in the respective operating and service manuals.

3-35. Parameter Serial Data Output (OPT. 002).

3-36. The 4261A option 002 is capable of outputting three kinds of data selectable by switching the internal slide switch mounted on the option board (see Figure 3-15). The first form (LCR mode) for data output is to continuously output inductance, capacitance or resistance values. The second (LCR & D mode), it to output inductance, capacitance or resistance and dissipation factor data alternately through one rear connector. The third form (D mode) is dissipation factor only continuously outputted from 4261A connector. In resistance measurements, the first LCR mode should be selected because 4261A dissipation factor in resistance measurements is meaningless. Printout format for Option 002 through one connector is the same as that for 4261A option 001 (refer to Figure 3-13). The connections between the option 002 and the external devices which are HP printers (in this case) are shown in Figure 3-16. Operating procedure for an instrument equipped with option 002 is the same as for a standard 4261A except for connections to the external device. Information for external device (e.g. printer) operation can be obtained from the operating and service manual.

3-37. Remote Control OPT. 003.

3-38. All the front panel controls except for DC BIAS can be remotely selected by control signals through the rear connector of an option 003 instrument. Remote control devices should be designed by the 4261A user since a specially designed controller from HP for the 4261A is not available. Information needed for controller design is presented in Figure 3-17. This includes pin locations, control signals and timing diagram. Controller design should include the following considerations:

1. $\overline{\text{REM}}$ signal must be always at low level during remote control. If not, remote control functions will not occur.
2. $\overline{\text{EXE}}$ signal triggers the 4261A when its state changes from low to high level. Pulse width of $\overline{\text{EXE}}$ must be greater than 20 μs.
3. Remote control settings for the 4261A from remote controller should not be changed during a 4261A measurement cycle. If changed during measurement cycle, the measured values will not be reliable because of operational error in the 4261A.

3-41. OPERATOR MAINTENANCE.

3-42. Fuse Replacement.

3-43. The main ac line fuse is located at the rear of the instrument next to the line cord jack. The ac line cord must be removed to gain access to the fuse

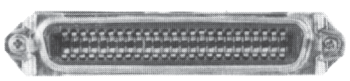
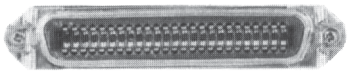
4261A FUNCTION Setting / Rear Connector	L	C	R
LCR DATA OUTPUT 	Inductance Value Polarity Annunciation/Test Frequency Range Function/CKT Mode	Capacitance Value Polarity Annunciation/Test Frequency Range Function/CKT Mode	Resistance Value Polarity Annunciation/Test Frequency Range Function/CKT Mode
D DATA OUTPUT 	D Value Polarity Annunciation/Test Frequency Function/CKT Mode	D Value Polarity Annunciation/Test Frequency Function/CKT Mode	1999 Polarity Annunciation/Test Frequency Function/CKT Mode

Figure 3-12. Data Outputted by Option 001.

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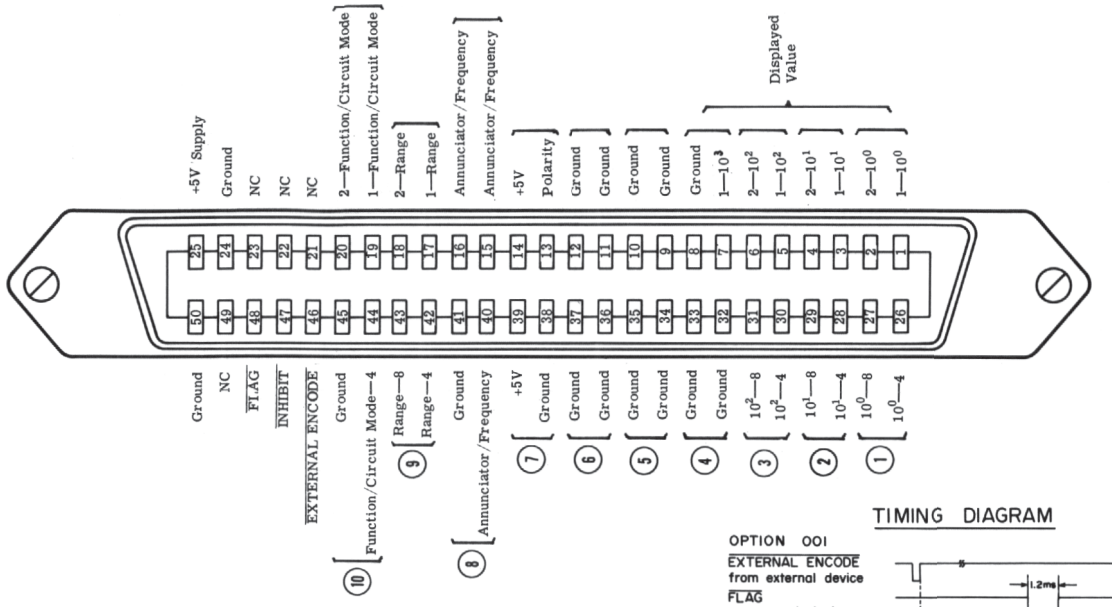
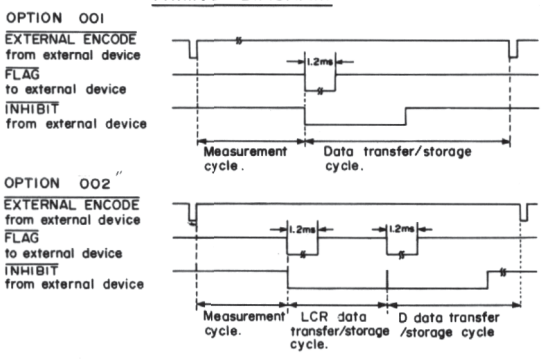
(I) PIN LOCATIONS (LCR DATA OUTPUT, D DATA OUTPUT)



○: Column Number

TIMING DIAGRAM



(II) PRINTOUT FORMAT

Nomenclature of Data (Column No.)	4261A Display	Character Printed
Displayed L/C/R/D Value (1 thru 4)	0	0
	1	1
	2	2
	3	3
	4	4
	5	5
	6	6
	7	7
	8	8
	9	9

Nomenclature of Data (Column No.)	4261A Display	Character Printed
Polarity (7)	+ (Blanked)	+
	-	-

Nomenclature of Data (Column No.)	4261A Display/Setting		Character Printed
Annunciation & Test Frequency (8)	No Annunciation	120Hz	0
		1kHz	4
	OUT OF RANGE	120Hz	1
		1kHz	5
	D Unavailable	120Hz	2
		1kHz	6
	OUT OF RANGE & D Unavailable	120Hz	3
		1kHz	7

Nomenclature of Data (Column No.)	4261A Full Scale Display			Character Printed
	L	C	R	
Range * (9)	100.0μH	100.0pF	1000 mΩ	1
	1000 μH	1000 pF	10.00Ω	2
	10.00mH	10.00nF	100.0Ω	3
	100.0mH	100.0nF	1000 Ω	4
	1000 mH	1000 nF	10.00kΩ	5
	10.00H	10.00μF	100.0kΩ	6
	100.0H	100.0μF	1000 kΩ	7
	1000 H	1000 μF	10.00MΩ	8
		10.00mF		9

* Range character for dissipation factor is always "0" (zero).

Nomenclature of Data (Column No.)	4261A Display			Character Printed
	L	C	R	
Function & Circuit Mode (10)	Parallel(Lp)			2
	Series(Ls)			3
		Parallel(Cp)		0
		Series(Cs)		1
			Parallel(Rp)	4
			Series(Rs)	5

Figure 3-13. Printout Format and Data Code Meanings.

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compartment. The fuse may be removed by pulling FUSE PULL lever inside the fuse compartment. For 100 or 120 Vac supply source, use a 500mA fuse and for a 220 or 240Vac supply source, use a 250mA line fuse.

CAUTION

BE SURE THAT ONLY FUSES OF SPECIFIED TYPE (NORMAL BLOW, TIME DELAY, ETC.) AND REQUIRED RATED CURRENT ARE USED FOR REPLACEMENT. THE USE OF FUSES AND THE SHORT CIRCUITING OF FUSE HOLDERS MUST BE AVOIDED.

3-44. Foot and Stand Replacement.

3-45. The 4261A has four molded feet and two tilt stands for stable bench mounting. If a foot is cracked or the stand is bent, replace with new part. See instructions in Figure 3-18.

3-46. Instruction Card Replacement.

3-47. If the "pull-out" Instruction Card installed along the lower right front edge of the instrument requires replacement, proceed as follows (see Figure 3-19):

a. Remove the four feet from bottom cover.

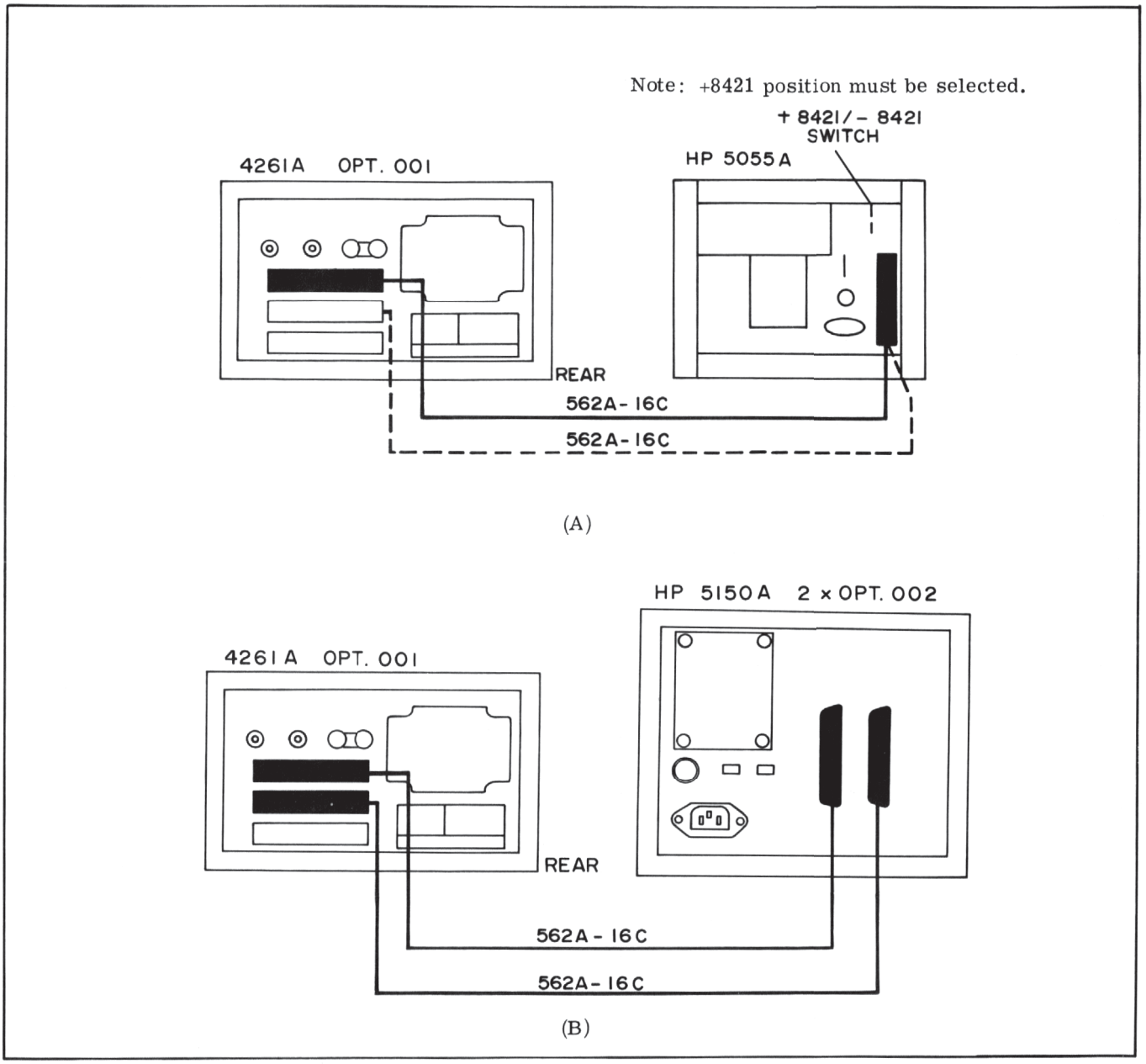

Figure 3-14. 4261A Connections to HP Printers.

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b. Remove bottom cover by removing screw at rear and sliding cover to rear.

c. Remove button stopper from instruction card.

d. Pull card from front panel.

e. Insert new card into front panel slot.

f. Attach button stopper.

g. Replace bottom cover and feet.

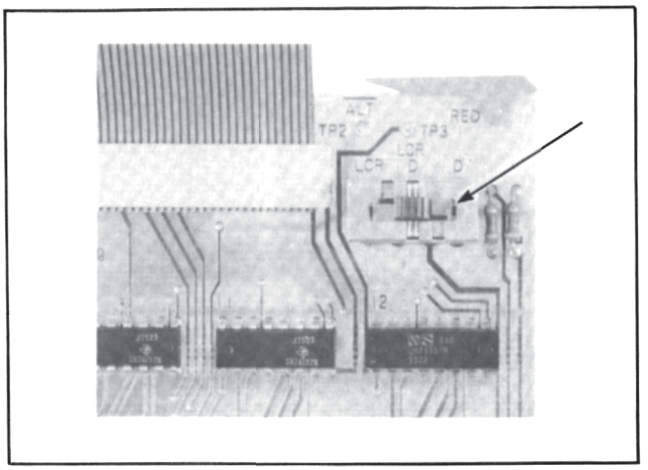

Figure 3-15. Option 002 Data Selection Switch.

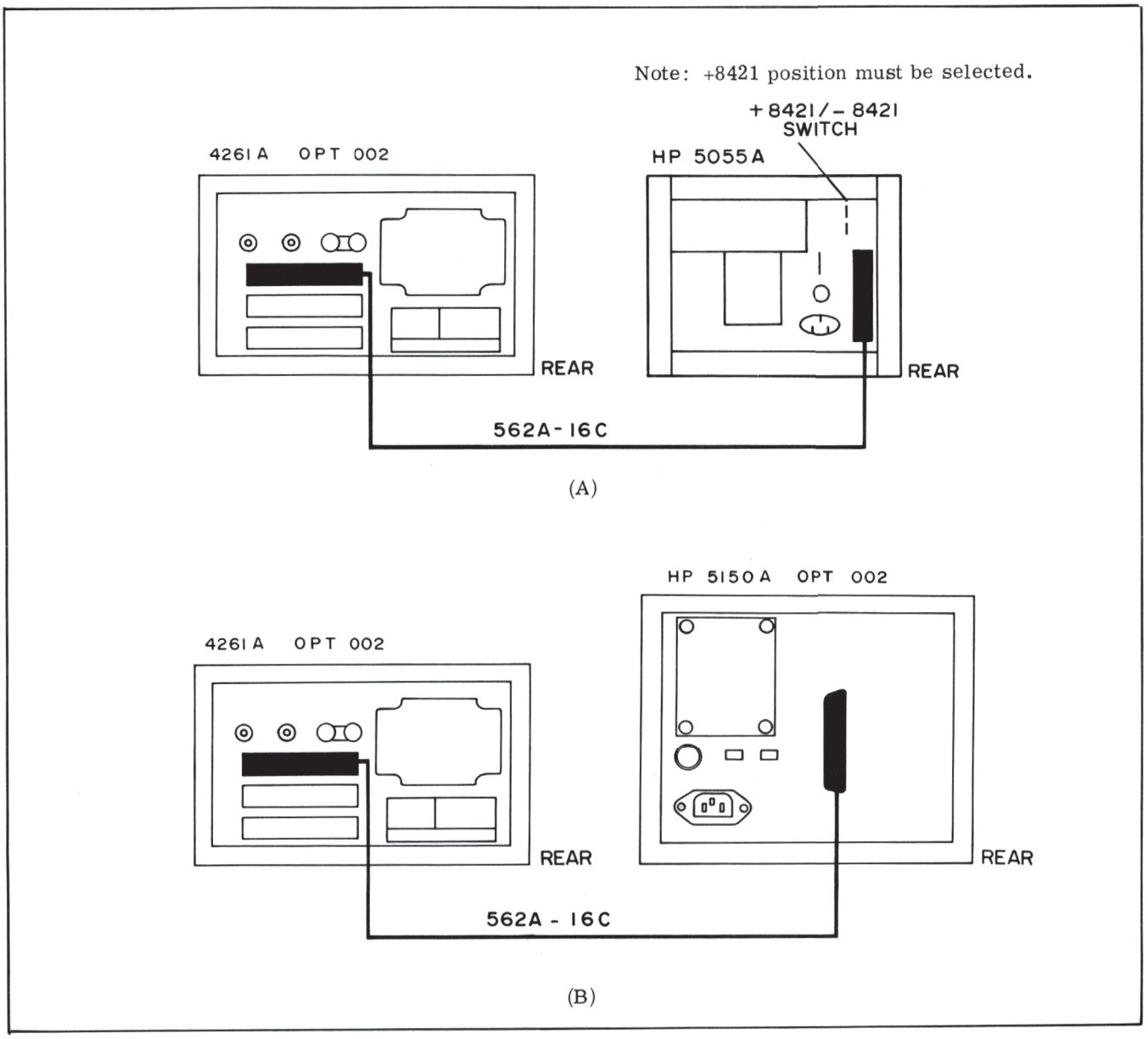

Figure 3-16. Option 002 Connection to External Printers.

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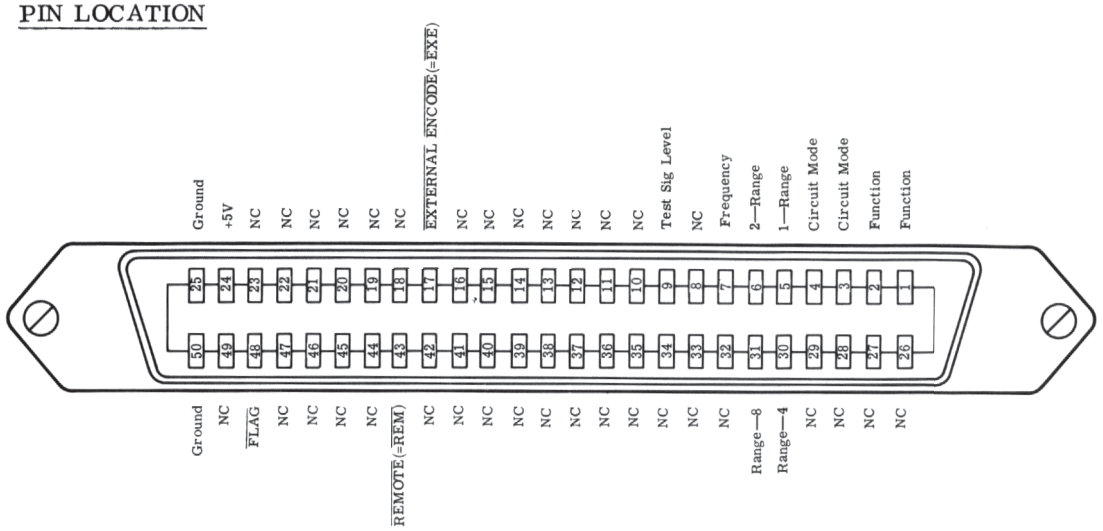
PIN LOCATION



REMOTE CONTROL FORMAT

FUNCTION	PIN	
	1	2
L	High	High
C	Low	Low
R	High	Low

CIRCUIT MODE	PIN	
	3	4
AUTO	*	High
PARALLEL	Low	Low
SERIES	High	Low

FREQUENCY	PIN
	7
120Hz	High
1kHz	Low

TEST SIG LEVEL	PIN
	9
50mV	High
1 V	Low

Range	PIN				Full Scale Measurement Range			
	5	6	30	31	FUNCTION / FREQUENCY	L	C	R
1	Low	Low	Low	Low	120Hz	1000 μH	1000 pF	1000 mΩ
					1kHz	100.0μH	100.0pF	
2	High	Low	Low	Low	120Hz	10.00mH	10.00nF	10.00Ω
					1kHz	1000μH	1000 pF	
3	Low	High	Low	Low	120Hz	100.0mH	100.0nF	100.0Ω
					1kHz	10.00mH	10.00nF	
4	High	High	Low	Low	120Hz	1000 mH	1000 nF	1000 Ω
					1kHz	100.0mH	100.0nF	
5	Low	Low	High	Low	120Hz	10.00H	10.00μF	10.00kΩ
					1kHz	1000 mH	1000 nF	
6	High	Low	High	Low	120Hz	100.0H	100.0μF	100.0kΩ
					1kHz	10.00H	10.00μF	
7	Low	High	High	Low	120Hz	1000 H	1000 μF	1000 kΩ
					1kHz	100.0H	100.0μF	
8	High	High	High	Low	120Hz	1000 H	10.00mF	10.00MΩ
					1kHz	100.0H	1000 μF	
Auto	*	*	*	High	120Hz	1000 μH-1000 H	1000 pF-10.00mF	1000 mΩ-10.00MΩ
					1kHz	100.0μH-100.0H	100.0pF-1000 μF	

Note: High is TTL High level (>2.0V) and Low is TTL Low level (<0.8V).

*: Either logic state can be selected.

Figure 3-17. Option 003 Remote Control (Sheet 1 of 2).

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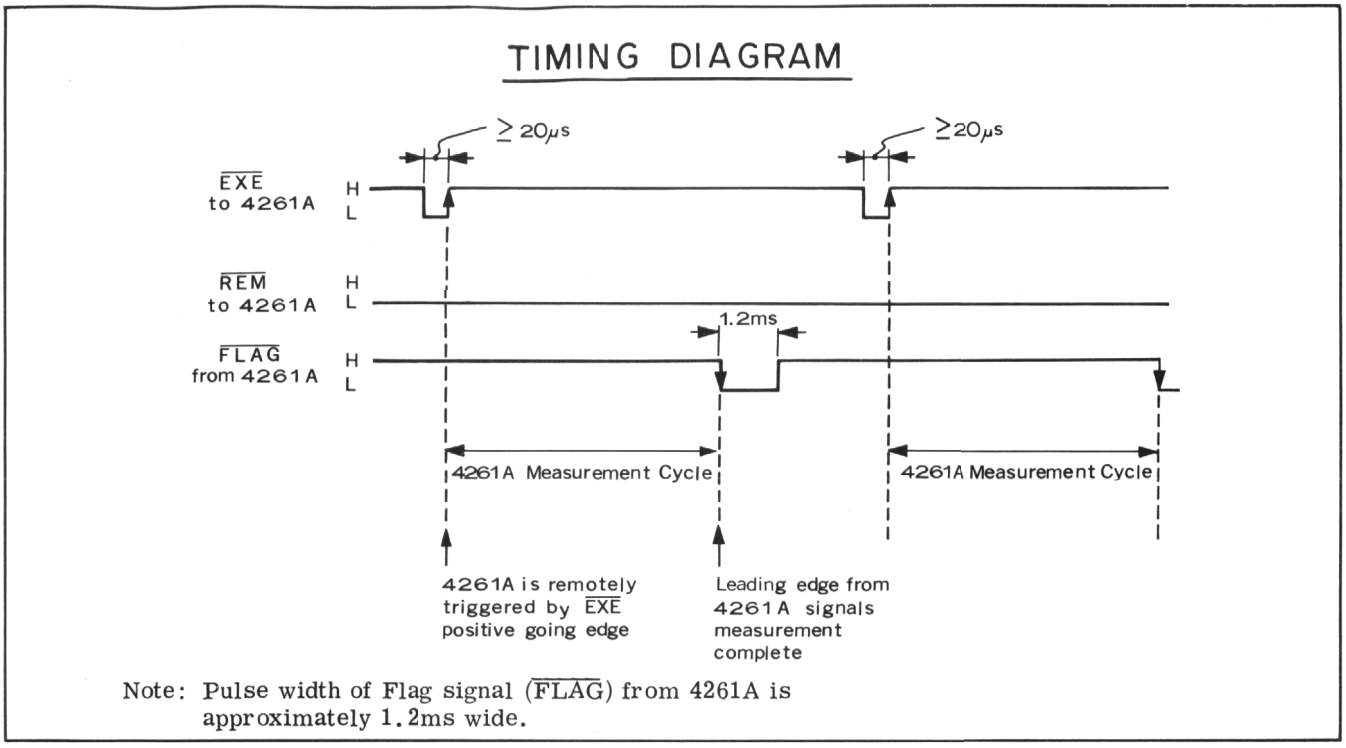

Note: Pulse width of Flag signal (FLAG) from 4261A is approximately 1.2ms wide.

Figure 3-17. Option 003 Remote Control (Sheet 2 of 2).

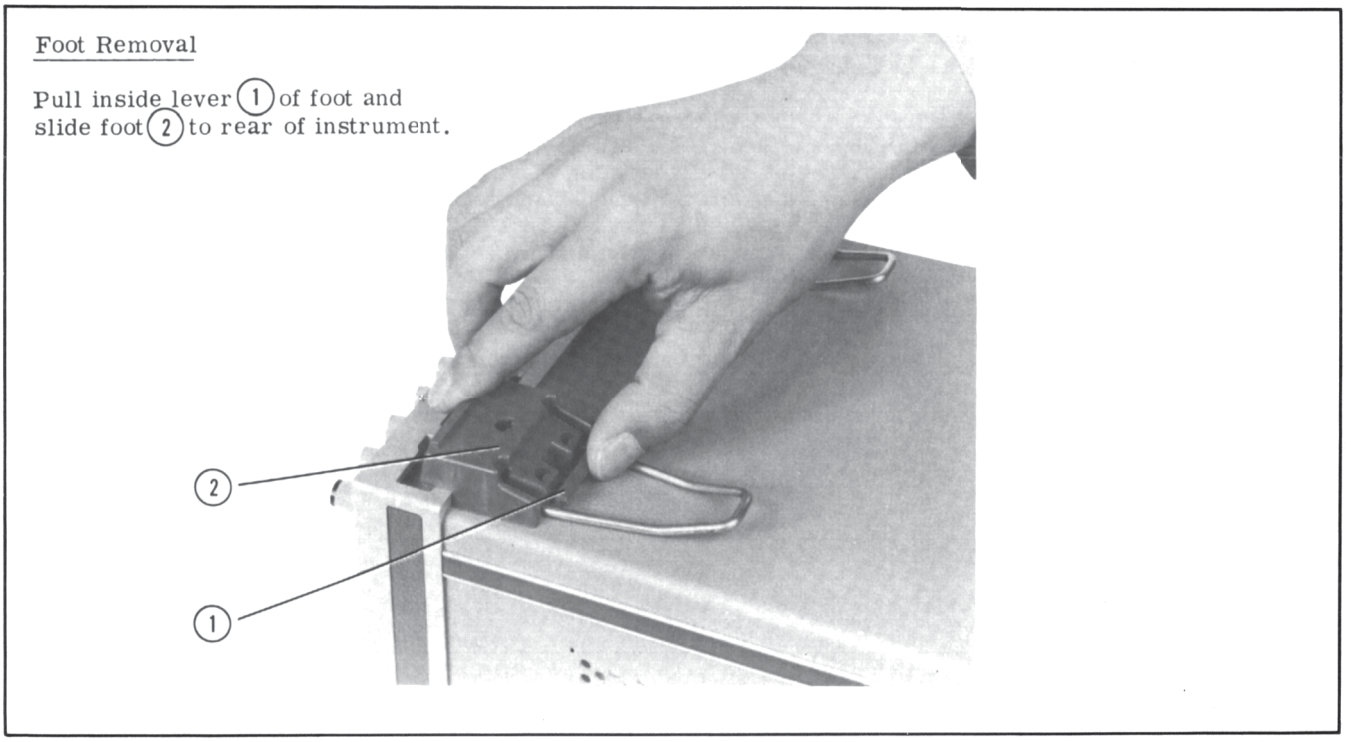

Figure 3-18. Foot/Stand Replacement.

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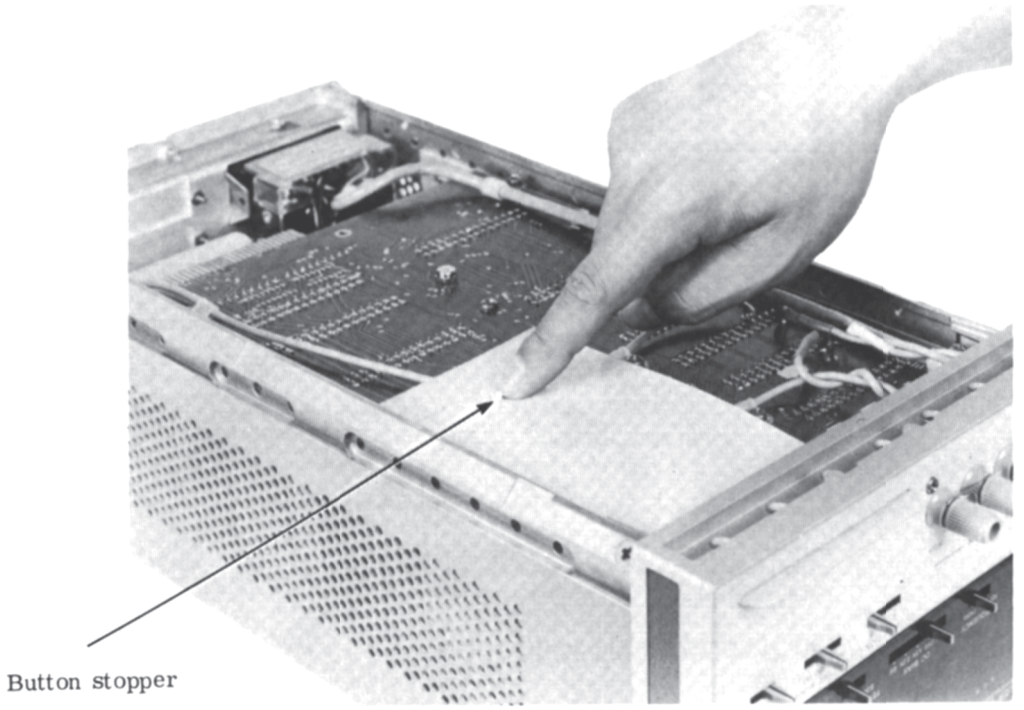

Figure 3-19. Instruction Card Replacement.

3-48. Special Modifications.

3-49. Two special functions may be added to the Model 4261A by changing the internal connections on a PC board which are easily done. These two functions are "Dissipation Factor Display Blanking" and "Local Triggering for Opt. 003". The following paragraphs describe the functions including modification procedures.

3-50. Dissipation Factor Display Blanking.

3-51. The Dissipation factor measurement can be deleted from C-D or L-D measurement modes by shorting two points (through holes) together on the A8 (04261-77108) board. This modification may be performed when D measurement and D display is not needed. This permits the measurement time to be decreased by 80 milliseconds (minimum at 1kHz) or 220 milliseconds (minimum at 120Hz). Modification procedure for deleting Dissipation Factor measurement follows:

1. Turn 4261A LINE to OFF.
2. Remove top cover from the unit.
3. Take out A8 board (04261-77108).
4. Short the two PC board points labelled "W1" and located at the left top of A8 board together (see parts locations in service sheet No. 8).

CAUTION

BE CAREFUL NOT TO SHORT ADJACENT PC BOARD CIRCUIT PATTERNS TOGETHER.

5. Reinstall A8 board and instrument cover.

3-52. Local Triggering for OPT. 003.

3-53. The 4261A can normally only be triggered by an external control device when equipped with an option 003. This modification enables local trigger of the option 003 unit from front panel without using an external device. The procedure to add this function is given below:

1. Turn 4261A LINE to OFF.
2. Remove top cover from the unit.
3. Take out A8 board (04261-77108).
4. Short together two PC board points labelled "W2" and located at left bottom of A8 board. (See part locations in service sheet No. 8).

CAUTION

BE CAREFUL NOT TO SHORT ADJACENT PC BOARD CIRCUIT PATTERNS TOGETHER.

5. Reinstall A8 board and instrument cover.

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SECTION IV
PERFORMANCE TESTS

4-1. INTRODUCTION.

4-2. This section provides the check procedures that verifies the 4261A specifications *listed* in Table 1-1. All tests can be performed without access to the interior of the instrument. A simpler operational test is presented in Section III under Operating Check (paragraph 3-5). The performance test procedures in this section can also be used to do the incoming inspection of the instrument and to verify whether the instrument meets its specified performance after troubleshooting or making adjustments. If specifications are found to be out of limits, check that controls are properly set, and then proceed to adjustments or troubleshooting.

Note

Allow a 15-minute warm-up and stabilization period before conducting any performance test.

4-3. EQUIPMENT REQUIRED.

4-4. Equipment required for the performance tests is listed in the Recommended Test Equipment table in Section I. Any equipment whose characteristics equal the critical specifications given in the table may be substituted for the recommended model(s).

Accuracy checks in this section use standard LCR components as the samples to be connected to the 4261A. HP Model 16361A DUT box, can be utilized for this purpose. HP 16361A is a DUT (device under test) box from which any desired component can be selected and connected to the 4261A through cables by use of a rotary switch. If HP 16361A is unavailable, use the discrete components recommended in Table 4-1 (See note in paragraph 4-10).

Note

All the components used as standards should be calibrated by an instrument whose specifications are traceable to NBS, PTB, LNE, NPL, NRC, JEMIC, or equivalent standards group; or all components should be calibrated directly by an authorized calibration organization such as NBS. The calibration cycle should be determined by the stability specification for each component.

4-5. TEST RECORD.

4-6. Results of the performance tests may be tabulated on the Test Record at the end of these procedures. The Test Record lists all the tested specifications and their acceptable limits. Test results recorded at incoming inspection can be used for comparison in periodic maintenance and troubleshooting and after repairs or adjustments.

4-7. CALIBRATION CYCLE.

4-8. This instrument requires periodic verification of performance. Depending on the use and environmental conditions, the instrument should be checked with the following performance tests at least once every year. To maximize the "up time" of the instrument, the recommended preventive maintenance frequency for the 4261A is twice a year.

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Table 4-1. Recommended Components for Accuracy Checks.

Component		HP Part Number	Alternate Source
Capacitor:	100pF	0160-0336	HP Model 4440B
	1000pF	0160-3766	
	10nF	0160-0408	
	100nF	0160-4113	
	1000nF	0160-3645	
	10μF	0160-3563	SOSHIN TM-520C
	1000μF	———	
	10mF	———	
Resistor:	1kΩ	0698-3491	GR Type 1433-Y
	10kΩ	0698-6360	
	100kΩ	0698-4158	
	10MΩ	0698-8194	
Inductor:	100mH	———	GR Type 1482-L
Dissipation Factor:			
1000nF in parallel with 887Ω		0160-3645	
(D ≈ 1.50 at 120Hz)		0698-4464	
100nF in parallel with 887Ω		0160-1571	
(D ≈ 1.79 at 1kHz)		0698-4464	

PERFORMANCE TESTS

4-9. MEASUREMENT FREQUENCY TEST.

SPECIFICATION:

Measurement Frequencies: 120Hz ±3%.
1kHz ±3%.

DESCRIPTION:

This test verifies the accuracy of the measurement frequencies that are applied to sample connected to the 4261A.

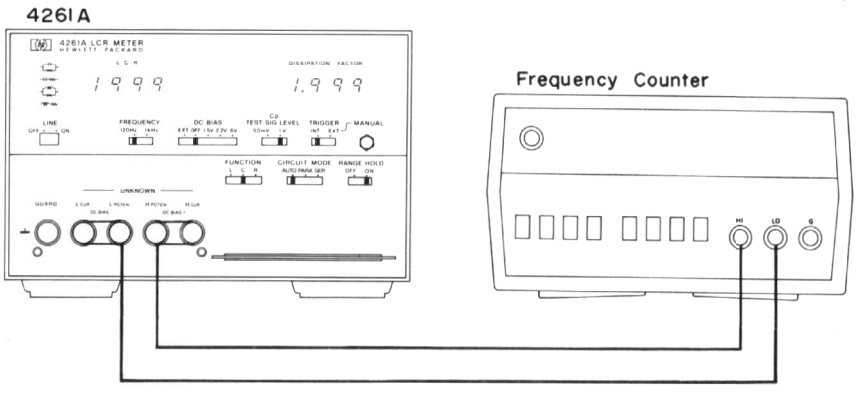

Figure 4-1. Measurement Frequency Test Setup.

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PERFORMANCE TESTS

EQUIPMENT:

Frequency Counter ..... HP 5300A/w5306A

PROCEDURE:

1. Connect frequency counter to the 4261A UNKNOWN terminals as shown in Figure 4-1.
2. Set range of frequency counter as appropriate for measuring 4261A test frequencies of 120Hz and 1kHz.
3. Read display output of frequency counter when 4261A FREQUENCY is set to 120Hz or 1kHz.
4. Frequency readouts must be within the following limits (record measured frequency in table below as the data is used in paragraph 4-12):

FREQUENCY	Test Limit	Counter Readout
120Hz	116.4 - 123.6Hz	
1kHz	970 - 1030Hz	

Note

Test limits in table above do not take into account reading error caused by measurement error in test equipment.

5. If this test can not be met, refer to troubleshooting in Section VIII.

4-10. CAPACITANCE AND DISSIPATION FACTOR ACCURACY TEST.

Note

If the following tests satisfy the accuracy specifications, all the accuracy specifications listed in Table 1-1 are guaranteed.

(I) Capacitance and Dissipation Factor Accuracy

FREQ	CIRCUIT MODE	Cp TEST SIG LEVEL	100.0pF	1000pF	10.00nF	100.0nF	1000nF	10.00μF
120Hz	PARA	50mV	⊠					
		1V	⊠					
	SER	1V	⊠	⊠	⊠	⊠		
1kHz	PARA	50mV						⊠
		1V						⊠
	SER	1V	⊠	⊠	⊠			

□ VALID RANGE

⊠ NON-APPLICABLE RANGE FOR LISTED VALUE OF STANDARD

Tests for dissipation factor accuracy with above capacitance standards should be done at the same time as capacitance tests.

Check all parallal (PARA) mode ranges. It is sufficient to check any one range in series (SER) mode.

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(II) Resistance Accuracy

Resistance accuracy has only to be proved for one resistor of about full scale value on any one range to verify specifications for both 120Hz and 1kHz.

(III) Inductance Accuracy

Inductance accuracy has only to be proved for one inductor of about full scale value on any one range to verify specifications for both 120Hz and 1kHz.

(IV) Dissipation Factor Accuracy

Dissipation factor accuracy for one D standard which has a D value of approx. 1. 8 need only be proved to guarantee D accuracy.

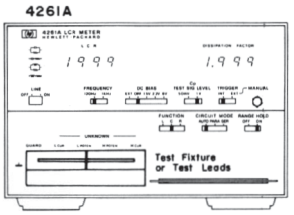
Test items, except for those listed above, are also included in the performance test items outlined in paragraphs 4-10 thru 4-13.

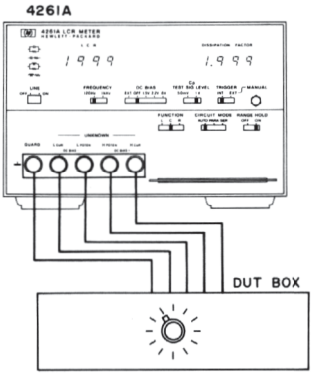
Tests, other than those listed above, can not be made unless the test components to perform such tests are available.

DESCRIPTION:

This test checks capacitance and dissipation factor measurement accuracies for zero and full scale displays at two test frequencies and at two signal levels. This test is made by connecting a stable capacitor more accurate than the 4261A to the instrument and reading the display to verify that the 4261A meets its measurement accuracy specifications. Check all ranges in Cp mode and one range in Cs mode at both 120Hz and 1kHz frequencies to guarantee C and D measurement accuracies since all variable elements (range resistors and detecting phases) needed for C and D measurements are thus checked. In this test, almost all ranges, from minimum through maximum ranges, are being verified.

(A)





(B)

Note: Either setup can be used.

Figure 4-2. Capacitance Accuracy Test Setup.

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PERFORMANCE TESTS

SPECIFICATIONS:

C-D MEASUREMENT

Range		120Hz 1kHz	1000pF 100.0pF	10.00nF 1000pF	100.0nF 10.00nF	1000nF 100.0nF	10.00μF 1000nF	100.0μF 10.00μF	1000μF 100.0μF	10.00mF 1000μF
	D	0.001 to 1.900, 1 range, common to all C ranges								
C Accuracy *1 *2			0.2% + 1 count + 0.2pF					(Test signal level; 1V)		
			0.5% 3 counts	0.3% + 2 counts				(Test signal level; 50mV)		
						0.3% + 2 counts			0.5% + 2counts	1% + 2counts *3
		AUTO	Same as Mode				Same as Mode			
D Accuracy *1			0.2% + (2 + 100/Cx) counts					(Test signal level; 1V)		
				0.3% + (2 + 1000/Cx) counts				(Test signal level; 50mV)		
						0.3% + (2 + Cx/500) counts				1% + (5 + Cx/500) counts
		AUTO	Same as Mode				Same as Mode			

*1. ± (% of reading + counts + α). Cx is capacitance readout in counts.
*2. C accuracies are applicable only when D value is less than 1.901. See Table 1-2 for C accuracies when D is more than 1.900.
*3. 5% + 2 counts at 1kHz.

Accuracy applies over a temperature range of 23°C ±5°C (at 0°C to 55°C, error doubles).

EQUIPMENT:

Test Fixture or Leads ..... HP 16061A
DUT Box ..... HP 16361A

Note

User built test fixture or DUT box may be used instead of those HP provides. If user supplied, the residual impedance and stray capacitance of the fixture and box must be taken into account.

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PERFORMANCE TESTS

PROCEDURE:

1. Connect test fixture or leads to 4261A UNKNOWN terminals. If DUT box is available, connect it to 4261A.

2. Set 4261A FUNCTION to C, RANGE HOLD to OFF and DC BIAS to OFF.

3. Confirm that the following table is satisfied when the measurements are made by changing FREQUENCY, CIRCUIT MODE, Cp TEST SIG LEVEL and DUT as given in table below. Record capacitance and dissipation factor readings in blank spaces provided in table.

FREQ	CIRCUIT MODE	SIGNAL LEVEL	0pF	100pF	1000pF	10nF	100nF	1000nF	10μF	1000μF	10mF
120Hz	PARA	50mV	C.V.* ±3 counts (———)	C.V. ±4 counts (———)	C.V. ±8 counts (———)	C.V. ±5 counts (±3 counts)	C.V. ±5 counts (±3 counts)	C.V. ±5 counts (±3 counts)	C.V. ±5 counts (±3 counts)		
		1V	C.V. ±2 counts (———)	C.V. ±2 counts (±4 counts)	C.V. ±4 counts (±3 counts)	C.V. ±3 counts (±3 counts)	C.V. ±3 counts (±3 counts)	C.V. ±3 counts (±3 counts)	C.V. ±3 counts (±3 counts)		
	SER	1V					C.V. ±3 counts (±3 counts)	C.V. ±5 counts (±4 counts)	C.V. ±5 counts (±4 counts)	C.V. ±7 counts (±4 counts)	C.V. ±12 counts (±7 counts)
1kHz	PARA	50mV	C.V. ±3 counts (———)	C.V. ±8 counts (———)	C.V. ±5 counts (±3 counts)	C.V. ±5 counts (±3 counts)	C.V. ±5 counts (±3 counts)	C.V. ±5 counts (±3 counts)			
		1V	C.V. ±3 counts (———)	C.V. ±5 counts (±3 counts)	C.V. ±4 counts (±3 counts)	C.V. ±3 counts (±3 counts)	C.V. ±3 counts (±3 counts)	C.V. ±3 counts (±3 counts)			
	SER	1V				C.V. ±3 counts (±3 counts)	C.V. ±5 counts (±4 counts)	C.V. ±5 counts (±4 counts)	C.V. ±5 counts (±4 counts)	C.V. ±52 counts (±7 counts)	

*C.V. = Calibrated Value of Standard Component

Test limits in parenthases are those for dissipation factor measurement values.

Note

Error caused by stability of standard component is not taken into account for test limits in table above.

If tests fail, proceed to Section V ADJUSTMENTS or Section VIII SERVICE.

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PERFORMANCE TESTS

4-11. RESISTANCE ACCURACY TEST.

SPECIFICATION:

R MEASUREMENT

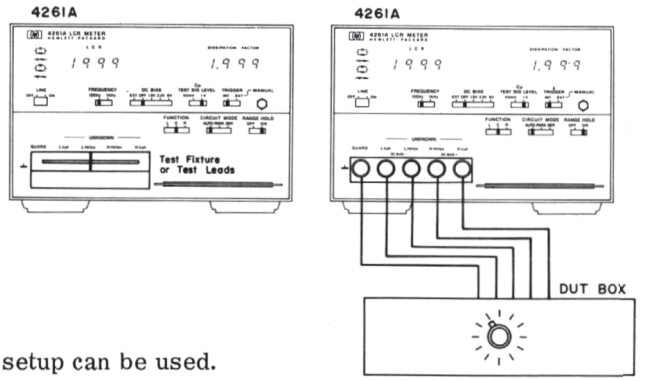
RANGE	120Hz or 1kHz	1000mΩ	10.00Ω	100.0Ω	1000Ω	10.00kΩ	100.0kΩ	1000kΩ	10.00MΩ
R Accuracy		—			0.3% + 2 counts				
*1		0.2% + 2 counts					—		
	AUTO	Same as Mode				Same as Mode			

*1. ± (% of reading + counts).

Accuracy applies over a temperature range of 23°C ±5°C (at 0°C to 55°C, error doubles).

DESCRIPTION:

This test verifies that resistance measurement accuracies for 4261A tested meets the specifications listed above. Standard resistors (listed in table 4-1) are used to check the accuracies. The DUT box (HP16361A) can also be utilized. Although R measurement accuracies are actually guaranteed when C measurement accuracies meet the specifications, almost all ranges in Rp mode are checked in this test.



Note: Either setup can be used.

Figure 4-3. Resistance Accuracy Test Setup.

EQUIPMENT:

Test Fixture or Leads..... HP 16061A
DUT Box ..... HP 16361A

Note

User built fixture/leads or DUT box can be used. If user supplied, the residual resistance must be considered.

PROCEDURE:

1. Connect test fixture or leads to 4261A UNKNOWN terminals. If DUT box is available, connect it to 4261A.

2. Set 4261A FUNCTION to R, CIRCUIT MODE to PARA, and FREQUENCY to 1kHz.

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3. Check that the resistance measurement accuracies meet specifications according to table below:

C.V. = Calibrated Value of Standard Component

DUT	1kΩ	10kΩ	100kΩ	10MΩ
Test Limits	C.V. ±5 counts	C.V. ±5 counts	C.V. ±5 counts	C.V. ±5 counts
R Readout				

Note

Error caused by stability of standard component is not taken into account for test limits in table above.

Note

If this test fails, go to Section V or Section VIII for the troubleshooting.

4-12. DISSIPATION FACTOR CONFIRMATION CHECK

SPECIFICATIONS:

C-D MEASUREMENT

Range									
	C	120Hz 1kHz	1000pF 100.0pF	10.00nF 1000pF	100.0nF 10.00nF	1000nF 100.0nF	10.00μF 1000nF	100.0μF 10.00μF	1000μF 100.0μF	10.00mF 1000μF
	D	0.001 to 1.900, 1 range, common to all C ranges								
D Accuracy *1		0.2% + (2 + 100/Cx) counts					(Test signal level; 1V)			
		0.3% + (2 + 1000/Cx) counts					(Test signal level; 50mV)			
		0.3% + (2 + Cx/500) counts								1% + (5 + Cx/500) counts
	AUTO	Same as Mode					Same as Mode			

*1. ± (% of reading + counts + α). Cx is capacitance readout in counts.

Accuracy applies over a temperature range of 23°C ±5°C (at 0°C to 55°C, error doubles).

L-D MEASUREMENT

Range									
	L	120Hz 1kHz	1000μH 100.0μH	10.00mH 1000μH	100.0mH 10.00mH	1000mH 100.0mH	10.00H 1000mH	100.0H 10.00H	1000H 100.0H
	D	0.001 to 1.900, 1 range, common to all L ranges.							
D Accuracy *1		0.3% + (3 + Lx/500) counts						1% + (3 + Cx/500) counts	
		0.2% + (3 + 200/Lx) counts							
	AUTO	Same as Mode					Same as Mode		

*1. ± (% of reading + counts). Lx is inductance readout in counts.

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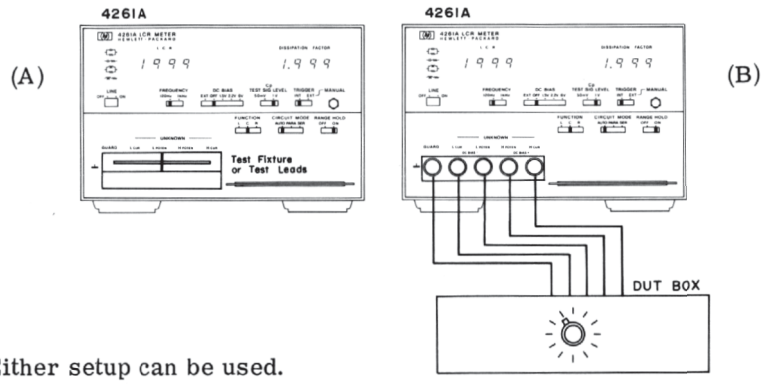
PERFORMANCE TESTS

DESCRIPTION:

This test verifies that a tested 4261A satisfies dissipation factor measurement accuracies. Only one Dissipation Factor (D = 1.8) is checked for both 120Hz and 1kHz in this check because only one detecting phase needs to be checked. All other factors influencing D accuracy were checked in paragraphs 4-10 and 4-11.



Note: Either setup can be used.

Figure 4-4. Dissipation Factor Check Setups.

EQUIPMENT:

Test Fixture or Leads ..... HP 16061A
DUT Box ..... HP 16361A

Note

HP 16361A DUT Box is equipped with D standards (D=1.8) calibrated at 1kHz frequency. For the test at 120Hz frequency or if DUT box is not available, it is recommended that the following DUT's be used as D standards:

DUT	Freq.	Values of components	Calculated D	Tolerance*
C R	120Hz	C : 1000nF(HP P/N 0160-3645) R : 887Ω (HP P/N 0698-4464)	1.495	±0.030
	1kHz	C : 100nF (HP P/N 0160-1571) R : 887Ω (HP P/N 0698-4464)	1.794	±0.036

* After calibrating capacitance C to within 0.1% and resistance R to within 0.02%, the dissipation factor tolerance is ±0.002 for each DUT.

PROCEDURE:

Note

If HP 16361A is available and connected to 4261A, perform procedure A. If not, do procedure B.

Procedure A:

1. Connect HP DUT Box 16361A to 4261A.
2. Set 4261A FUNCTION to C.
3. Check D accuracies according to following table:

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FREQ	CIRCUIT MODE	Cp TEST SIG LEVEL	D Test Limits	D Reading
1kHz	PARA	50mV	Calibrated Value · X ± 8 counts	
		1V	Calibrated Value · X ± 6 counts	
	SER	1V	Calibrated Value · X ± 2 counts	

Note

Error caused by stability of standard component is not taken into account for test limits in table above.

Procedure B:

1. Set 4261A FUNCTION to C and CIRCUIT MODE to PARA.
2. Connect D standard recommended in EQUIPMENT on page 4-9.
3. Check D accuracies according to following table:

FREQ	Cp TEST SIG LEVEL	D Test Limits	D Reading
120Hz	50mV	Calibrated Value · X ± 9 counts	
	1V	Calibrated Value · X ± 6 counts	
1kHz	50mV	Calibrated Value · X ± 9 counts	
	1V	Calibrated Value · X ± 6 counts	

Note: x in above table is produced by test frequency error and may be determined from the following equations:

120Hz: $x = \frac{fx}{120}$

1kHz: $x = \frac{fx}{1000}$

where fx is measured frequency from paragraph 4-9.

Note

Error caused by stability of standard component is not taken into account for test limits in table above. If the test fails, refer to Section VIII Service.

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PERFORMANCE TESTS

4-13. INDUCTANCE ACCURACY TEST.

SPECIFICATIONS:

L-D MEASUREMENT

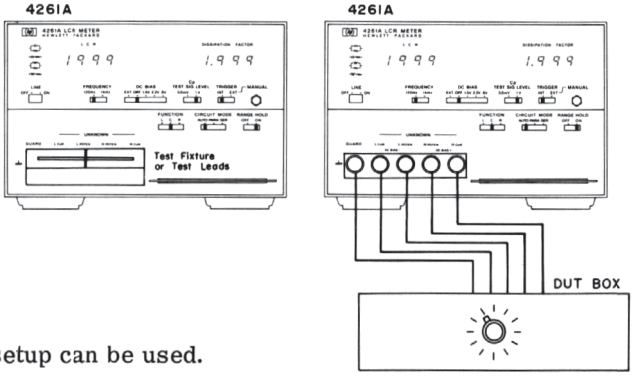
RANGE	120Hz 1kHz	1000μH 100.0μH	10.00mH 1000μh	100.0mH 10.00mH	1000mH 100.0mH	10.00H 1000mH	100.0H 10.00H	1000H 100.0H
L Accuracy		——			0.3% + 2 counts		1% + 2 counts	
*1		0.2% 2 counts + 0.2μH					——	
	AUTO	Same as Mode				Same as Mode		

*1. ± (% of reading + counts).

Accuracy applies over temperature range of 23° C ±5° C (at 0° C to 55° C, error doubles).

DESCRIPTION:

This test verifies that the inductance measurement accuracy satisfies the specifications listed above. L accuracy is proved to meet the specification when the results obtained in the accuracy checks of paragraphs 4-9 through 4-12 satisfies the specifications. This test is performed to confirm the L accuracy specification.



Note: Either setup can be used.

Figure 4-5. Inductance Accuracy Test Setups.

EQUIPMENT:

Test Fixture or Leads ..... HP 16061A
DUT Box ..... HP 16361A

Note

User built test fixture/leads or DUT box must take residual impedance into consideration.

PROCEDURE:

1. Connect Test Fixture or Leads to 4261A UNKNOWN terminals. If DUT box is available, connect it to the unit instead.

2. Set 4261A FUNCTION to L and Cp TEST SIG LEVEL to 1V.

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3. Connect 100mH inductor.

4. Confirm that L accuracy is within the test limits shown in table below:

Note

Test limits below are given for 100mH inductance measurement. If another inductance value is measured, refer to SPECIFICATIONS above.

FREQ	CIRCUIT MODE	Test Limits	L Readout
120Hz	PARA	Calibrated Value ± 3 counts	
	SER	Calibrated Value ± 3 counts	
1kHz	PARA	Calibrated Value ± 5 counts	
	SER	Calibrated Value ± 4 counts	

Note: Error caused by stability of standard component is not taken into account for test limits in table above. If this test fails, refer to Section VIII Service.

4-14. INTERNAL DC BIAS SOURCE TEST.

SPECIFICATIONS:

DC bias, Internal Source: 1.5V ±5%, 2.2V ±5%, 6V ±5%

DESCRIPTION:

This test verifies that the internal dc bias source will apply the specified bias values to the device under test.

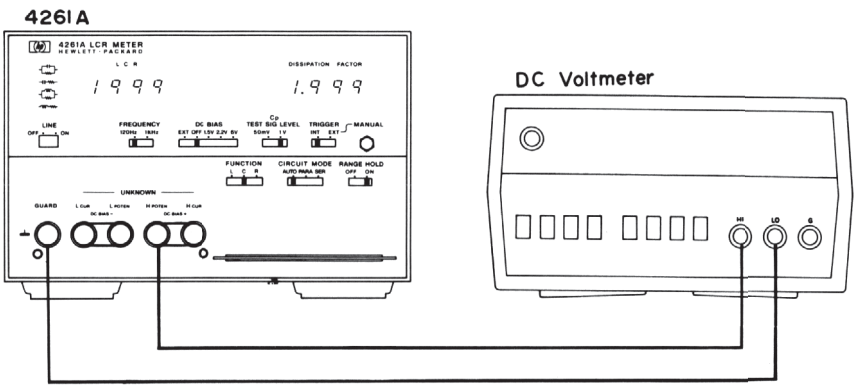

Figure 4-6. Internal DC Bias Source Test Setup.

EQUIPMENT:

DC Voltmeter ..... HP 5300A/w 5306A

PROCEDURE:

1. Connect DC Voltmeter to 4261A UNKNOWN terminals as shown in Figure 4-6.
2. Set 4261A controls as follows:

FUNCTION C
CIRCUIT MODE ..... PARA
Other Controls ..... any position

Note

Do not connect anything to UNKNOWN terminals.

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3. Test limits are shown below. Read dc voltmeter output with DC BIAS switch set as follows:

DC BIAS Switch Setting	Test Limit	Voltmeter Readout
1.5V	1.425V thru 1.575V	
2.2V	2.09V thru 2.31V	
6V	5.7V thru 6.3V	

Note

Reading error caused by measurement error of test equipment is not taken into account for test limits in table above.

4. If tests fail, proceed to Troubleshooting in Section VIII.

Table 4-2. Performance Test Summary.

Test Instrument Parameters	Performance Specifications	Test Method
Measurement Frequency	Test Frequencies: 120Hz and 1kHz. Accuracy, ±3%	Test frequency at High terminals is measured with electronic counter.
Capacitance Accuracy	Capacitance Measurement Accuracies: Cp, 1V: 0.2% +1 count +0.2pF *Cp, 50mV: 0.5% +3 counts or 0.3% +2 counts *Cs: 0.3% +2 counts, 0.5% +2 counts, 1% +2 counts or 5% +2 counts	Stable standard capacitor is connected to 4261A and 4261A is proved to be satisfactory with an accuracy test.
Resistance Accuracy	Resistance Measurement Accuracies: Rp: 0.3% +2 counts Rs: 0.2% +2 counts	Stable standard resistor is connected to 4261A and 4261A is proved to meet required accuracies.
Dissipation Factor Accuracy	D Measurement Accuracy: Cp, 1V: 0.2% + (2 + 200/Cs) counts *Cp, 50mV: 0.3% + (2 + 1000/Cs) counts *Cs: 0.3% +(2 + Cx/500) counts or 1% + (5 + Cx/500) counts *Lp: 0.3% + (3 + Lx/500) counts or 1% + 2 counts Ls: 0.2% + (3 + 200/Lx) counts	Stable D standard is connected to 4261A and 4261A is proved to meet required D accuracy specifications.
Inductance Accuracy	Inductance Measurement Accuracies: *Lp: 0.3% +2 counts or 1% +2 counts Ls: 0.2% +2 counts +0.2μH	Stable standard inductor is connected to 4261A and the 4261A is checked to verify accuracy specification.
Internal DC Bias Source Accuracy	DC Bias Voltage Accuracy: 1.5V 2.2V, 6V ±5%	Internal dc bias voltage at High terminals is measured with an

* Some accuracy specifications depend on range. Refer to Table 1-1, Specification pages 1 and 2 to determine how accuracies and ranges correspond with each other.

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Performance Test Record

Hewlett-Packard
Model 4261A
LCR METER
Serial No. _____

Tested by _____

Data _____

Paragraph Number	Test		Results		
			Minimum	Actual	Maximum
4-9	MEASUREMENT FREQUENCY TEST				
		120Hz	116.4	_____	123.6
		1kHz	970	_____	1030
4-10	CAPACITANCE ACCURACY TEST				
	120Hz PARA 50mV	0pF	C.V.*- 3 counts	_____	C.V. + 3 counts
		100pF	C.V. - 4 counts	_____	C.V. + 4 counts
		1000pF	C.V. - 8 counts	_____	C.V. + 8 counts
		10nF	C.V. - 5 counts	_____	C.V. + 5 counts
		100nF	C.V. - 5 counts	_____	C.V. + 5 counts
		1000nF	C.V. - 5 counts	_____	C.V. + 5 counts
		10μF	C.V. - 5 counts	_____	C.V. + 5 counts
	120Hz PARA 1V	0pF	C.V. - 2 counts	_____	C.V. + 2 counts
		100pF	C.V. - 2 counts	_____	C.V. + 2 counts
		1000pF	C.V. - 4 counts	_____	C.V. + 4 counts
		10nF	C.V. - 3 counts	_____	C.V. + 3 counts
		100nF	C.V. - 3 counts	_____	C.V. + 3 counts
		1000nF	C.V. - 3 counts	_____	C.V. + 3 counts
		10μF	C.V. - 3 counts	_____	C.V. + 3 counts
	120Hz SER 1V	100nF	C.V. - 3 counts	_____	C.V. + 3 counts
		1000nF	C.V. - 5 counts	_____	C.V. + 5 counts
		10μF	C.V. - 5 counts	_____	C.V. + 5 counts
		1000μF	C.V. - 7 counts	_____	C.V. + 7 counts
		10mF	C.V. - 12 counts	_____	C.V. + 12 counts
	1kHz PARA 50mV	0pF	C.V. - 3 counts	_____	C.V. + 3 counts
		100pF	C.V. - 8 counts	_____	C.V. + 8 counts
		1000pF	C.V. - 5 counts	_____	C.V. + 5 counts
		10nF	C.V. - 5 counts	_____	C.V. + 5 counts
		100nF	C.V. - 5 counts	_____	C.V. + 5 counts
		1000nF	C.V. - 5 counts	_____	C.V. + 5 counts

* C.V. = Calibrated Value.

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Paragraph Number	Test		Results		
			Minimum	Actual	Maximum
4-10	CAPACITANCE ACCURACY TEST (Continued)				
	1kHz PARA 1V	0pF	C.V.*- 3 counts	_____	C.V. + 3 counts
		100pF	C.V. - 5 counts	_____	C.V. + 5 counts
		1000pF	C.V. - 4 counts	_____	C.V. + 4 counts
		10nF	C.V. - 3 counts	_____	C.V. + 3 counts
		100nF	C.V. - 3 counts	_____	C.V. + 3 counts
		1000nF	C.V. - 3 counts	_____	C.V. + 3 counts
	1kHz SER 1V	10nF	C.V. - 3 counts	_____	C.V. + 3 counts
		100nF	C.V. - 5 counts	_____	C.V. + 5 counts
		1000nF	C.V. - 5 counts	_____	C.V. + 5 counts
		10 μF	C.V. - 5 counts	_____	C.V. + 5 counts
		1000 μF	C.V. - 52 counts	_____	C.V. + 52 counts
4-11	RESISTANCE ACCURACY TEST				
		1kΩ	C.V. - 5 counts	_____	C.V. + 5 counts
		10kΩ	C.V. - 5 counts	_____	C.V. + 5 counts
		100kΩ	C.V. - 5 counts	_____	C.V. + 5 counts
		10MΩ	C.V. - 5 counts	_____	C.V. + 5 counts
4-13	INDUCTANCE ACCURACY TEST (100mH)				
	120Hz	PARA	C.V. - 5 counts	_____	C.V. + 5 counts
		SER	C.V. - 4 counts	_____	C.V. + 4 counts
	1kHz	PARA	C.V. - 5 counts	_____	C.V. + 5 counts
		SER	C.V. - 4 counts	_____	C.V. + 4 counts
4-14	INTERNAL DC BIAS SOURCE TEST				
		1.5V	1.425	_____	1.575
		2.2V	2.09	_____	2.31
		6 V	5.7	_____	6.3

* C.V. = Calibrated Value.

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SECTION V
ADJUSTMENT

5-1. INTRODUCTION.

5-2. This section provides the information needed to adjust the 4261A to its specifications (listed in Table 1-1). Included in this section are test setups and procedures. Adjustment locations referred to in the individual tests are identified pictorically in Section VIII.

5-3. A fifteen minute instrument warm up is required before beginning the adjustments in this section. Required instruments for the adjustments are listed in Table 1-5. Besides the test instrumentation, only a screwdriver is needed to perform the adjustments.

5-4. SAFETY REQUIREMENTS.

5-5. Although the instrument has been designed in accordance with international safety standards, this manual contains information, cautions and warnings which must be followed to ensure safe operation and to keep the instrument in safe condition (see Sections II and III). Adjustments described in this section should be performed only by qualified service personnel.

WARNING

ANY INTERRUPTION OF THE PROTECTIVE (GROUNDING) CONDUCTOR (INSIDE OR OUTSIDE THE INSTRUMENT) OR DISCONNECTION OF THE PROTECTIVE EARTH TERMINAL IS LIKELY TO MAKE THE INSTRUMENT DANGEROUS. INTENTIONAL INTERRUPTION IS PROHIBITED.

5-6. The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts. Accessible terminals may also be live.

5-7. The instrument must be disconnected from all voltage sources before any adjustment. All work must be done by a technically skilled person who is aware of the hazard involved.

5-8. Capacitors inside instrument may still be charged even if instrument has been disconnected from its source of supply.

WARNING

ADJUSTMENTS DESCRIBED HEREIN ARE PERFORMED WITH POWER SUPPLIED TO THE INSTRUMENT AFTER PROTECTIVE COVERS HAVE BEEN REMOVED. ENERGY EXISTING AT MANY POINTS MAY, IF CONTACTED, RESULT IN PERSONAL INJURY.

5-9. EQUIPMENT REQUIRED.

5-10. Equipment needed to make the adjustments described in this section are listed in Table 1-5. (Page 1-9) of the Section I.

5-11. FACTORY SELECTED COMPONENTS.

5-12. Factory selected components can be recognized by an asterisk near the reference designator on the schematic diagrams in Section VIII (a nominal value is shown). Section VI, Replaceable Parts,

Table 5-1. Factory Selected Components.

Component	Nominal Value Range	Effect on Performance
A4C11	HP P/N 0160-2201 C:FXD 51pF HP P/N 0140-0205 C:FXD 62pF HP P/N 0140-0193 C:FXD 82pF HP P/N 0160-2202 C:FXD 75pF HP P/N 0160-2204 C:FXD 100pF	Maximizes D measurement accuracy on 100pF range (1kHz). If D display is low, use less capacitance; if high use more capacitance.
A4R26	HP P/N 0698-3259 R:FXD 7.87kΩ HP P/N 0757-0440 R:FXD 7.50kΩ HP P/N 0757-0441 R:FXD 8.25kΩ	Changes oscillator level. If oscillator level is insufficient, use more resistance; if excessive,use less resistance.

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Table 5-2. Adjustable Components

Reference Designator	Name of Control	Purpose
A4R87 (para. 5-19)	OFFSET	To eliminate dc offset in range resistor amplifier.
A5R31 (para. 5-20) A5R40 (para. 5-20)	OFFSET-1 OFFSET-2	To eliminate dc offset in differential amplifier.
A5R54 (para. 5-20)	OFFSET-3	To eliminate dc offset in measurement signal amplifier.
A5R85 (para. 5-22)	OFFSET-4	To set auto phase adjustment circuit for optimum functioning.
A6R67 (para. 5-21) A6R68 (para. 5-21)	PHASE OFFSET ZERO OFFSET	To eliminate dc offset in phase converter and zero detector.
A9R6 (para. 5-18)	+12V ADJ.	To set output of +12V dc power supply.

lists the part number of the nominal value component. If the nominal vlaue of the selected component is changed, the Manual Change supplement, supplied with this manual, will list the change to update the manual. Table 5-1 lists all factory selected components with their nominal value ranges and their influence on instrument performance.

5-13. Adjustable components, with reference designators, are listed in Table 5-2. The table gives the name of the control to be adjusted and the purpose of its adjustment.

5-14. ADJUSTMENT RELATIONSHIPS.

5-15. For best 4261A performance, adjustments presented in this section must be performed in the order indicated by the procedures. If adjustment is neglected, the 4261A specifications may not be met. Table 5-3 shows alignment procedures required when repairing the instrument (replacement of component or board). The adjustments in Table 5-3 assume that no other adjustments were attempted prior to board or component replacement.

5-16. ADJUSTMENT LOCATIONS.

5-17. For reference, adjustment location illustrations are given in Figure 8-15.

Table 5-3. Alignment Procedure

Assembly Repaired-Replaced	Required Adjustments
A1(04261-77001) A2(04261-77002) A3(04261-77103)	None
A4(04261-77004)	Para. 5-19 thru 5-22
A5(04261-77005)	Para. 5-19 thru 5-22
A6(04261-77006)	Para. 5-21 and 5-22
A7(04261-77007) A8(04261-77108)	None
A9(04261-77009)	Para. 5-18
A10(04261-77010) A21(04261-77021) A22(04261-77022)	None

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5-18. POWER SUPPLY VOLTAGE ADJUSTMENT.
Service Sheet No. 9.

DESCRIPTION:

This adjustment sets the dc power supply voltages for the 4261A internal circuits. Although there are three dc output voltages (+12V, -12V and +5V), only an adjustment of the +12V is required. The -12V and +5V are automatically set to appropriate values by +12V adjustment.

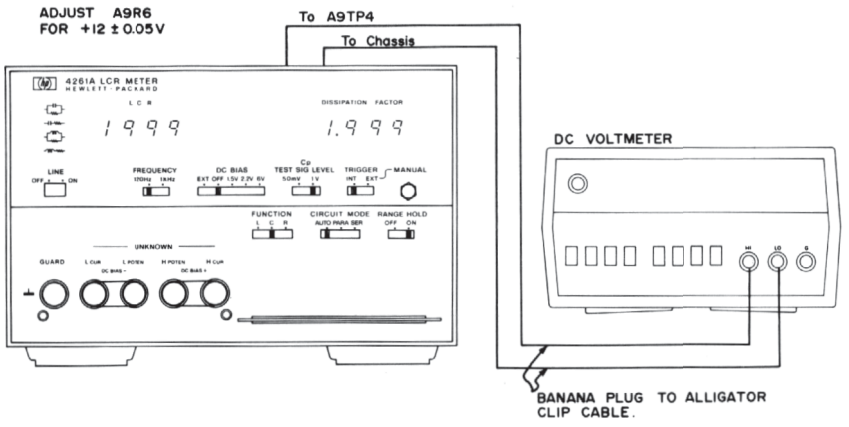

Figure 5-1. Power Supply Voltage Adjustment.

EQUIPMENT:

DC VOLTMETER ..... HP 5300A/w HP 5306A

PROCEDURE:

a. Connect voltmeter plus input to 4261A test point A9TP4 and minus input to 4261A chassis with dual banana plug to alligator clip cable. See Figure 5-1.

b. Set DC voltmeter range as appropriate for measuring +12 volts.

c. Adjust A9R6 "+12V" for +12 volts ±0.05 volts (see Figure 8-15 for location).

d. After adjustment of +12V, check that dc voltages at A9TP5 and A9TP6 are -12V ±0.15V and +5V ±0.15V, respectively.

e. Remove cables and DC voltmeter from 4261A.

Note

This adjustment is not affected by any other adjustment. If this adjustment fails to bring any of the output voltages to their specified values, refer to Section VIII Service Sheet No. 9 for troubleshooting.

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5-19. A4 BOARD OFFSET ADJUSTMENT.
Service Sheet No. 4.

DESCRIPTION:

This adjustment eliminates any residual dc offset voltage from range resistor amplifier to maximize accurate measurement.

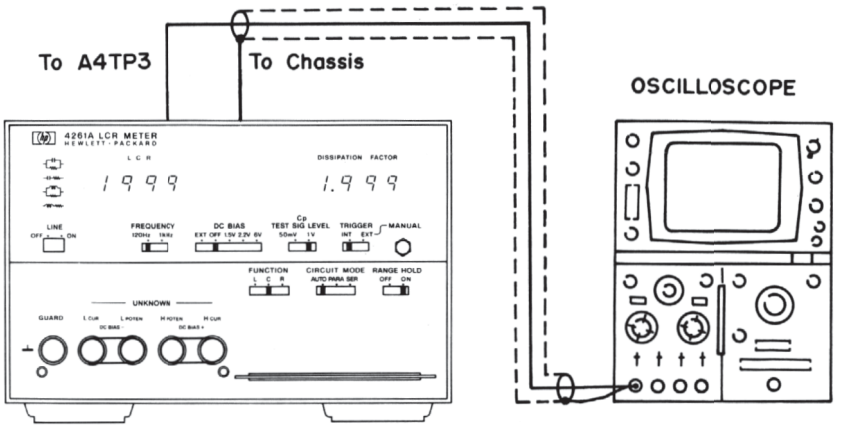

Figure 5-2. A4 Board Offset Adjustment.

EQUIPMENT:

Oscilloscope ..... HP 180C/w 1801A/w 1821A

PROCEDURE:

a. Connect BNC to alligator clip cable between oscilloscope and 4261A A4TP3 and 4261A chassis (see Figure 5-2).

b. Set 4261A controls as follows:

FREQUENCY	1kHz
DC BIAS	OFF
TEST SIG LEVEL	1V
TRIGGER	INT
FUNCTION	C
CIRCUIT MODE	PARA
RANGE HOLD	OFF

c. Connect nothing (open, ∞Ω) to UNKNOWN terminals.

Note

High terminals and Low terminals, respectively, must be connected together.

d. Set oscilloscope voltage sensitivity to 0.005 volts/div. and sweep speed to 0.5 milliseconds/div.

e. Set input mode of oscilloscope to ground. Adjust position control of oscilloscope so that baseline is centered on the CRT.

f. Set oscilloscope trigger mode to automatic. Set oscilloscope input mode to dc input.

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g. Adjust A4R87 OFFSET until dc level of displayed waveform is within 0mV ±2mV. Refer to Figure 5-3 which shows well-adjusted waveform.

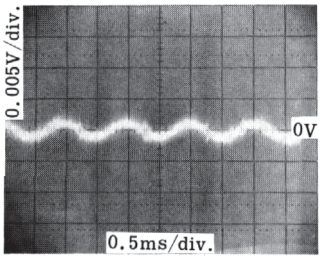

Figure 5-3. Waveform at A4TP3.

5-20. A5 BOARD OFFSET ADJUSTMENT.
Service Sheet No. 5.

DESCRIPTION:

This adjustment eliminates any residual dc offset voltage from the A5 board process amplifier assembly.

(I) To A5TP1 or
(II) To A5TP2 or
(III) To A5TP3

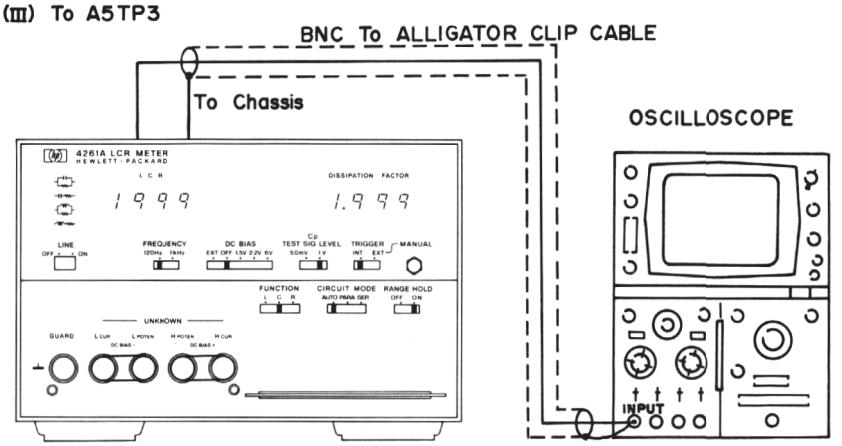

Figure 5-4. A5 Board Offset Adjustment.

EQUIPMENT:

Oscilloscope ..... HP 180C/w 1801A/w 1821A

Note

The adjustments in these steps can be performed separately. However, a power supply voltage adjustment (paragraph 5-18) must precede these adjustments. The A5 Board adjustments must be done prior to A6 Board offset adjustments (paragraph 5-21) and A5 Board final offset adjustments (paragraph 5-22). Adjustments in these steps may interact with other adjustments. If adjustments are not successful, see Section VIII service sheet for troubleshooting.

PROCEDURE:

(I) OFFSET-1 Adjustment

a. Connect BNC to alligator clip cable between oscilloscope and 4261A A5TP1 and 4261A chassis (see Figure 5-4).

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b. Set 4261A controls as follows:

FREQUENCY	1kHz
DC BIAS	OFF
TEST SIG LEVEL	1V
TRIGGER	INT
FUNCTION	L
CIRCUIT MODE	SER
RANGE HOLD	OFF

c. Short the four UNKNOWN terminals together.

d. Set oscilloscope voltage sensitivity to 0.005 volts/div. and sweep speed to 0.5 milliseconds/div.

e. Set input mode of oscilloscope to ground. Adjust position control of oscilloscope so that baseline is centered on the CRT.

f. Set oscilloscope trigger mode to automatic. Set oscilloscope input mode to dc input.

g. Adjust A5R31 OFFSET-1 until dc level of displayed waveform is within 0mV ±2mV. Refer to Figure 5-5 which shows well-adjusted waveform.

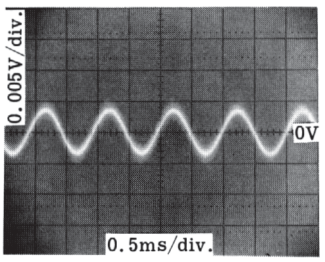

Figure 5-5. Waveform at A5TP1.

(II) OFFSET-2 Adjustment

a. Connect BNC to alligator clip cable between oscilloscope and 4261A A5TP2 and 4261A chassis (see Figure 5-4).

b. Change 4261A controls as follows:

FUNCTION	C
CIRCUIT MODE	PARA

c. Connect nothing between UNKNOWN high terminals and low terminals.

Note

High terminals and Low terminals, respectively, must be connected together.

d. Adjust A5R40 OFFSET-2 until dc level of displayed waveform is within 0mV ±2mV. Refer to Figure 5-6 which shows well-adjusted waveform.

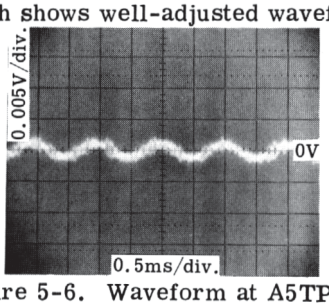

Figure 5-6. Waveform at A5TP2.

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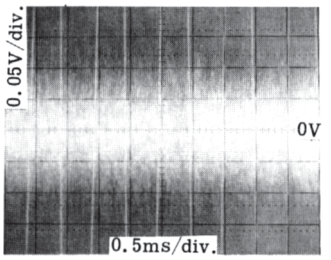
(III) OFFSET-3 Adjustment.

a. Connect BNC to alligator clip cable between oscilloscope and 4261A A5TP3 and 4261A chassis (see Figure 5-4).

b. Change 4261A Cp TEST SIG LEVEL to 50mV.

c. Change oscilloscope sensitivity to 0.05V/div.

d. Adjust A5R54 OFFSET-3 until dc level of displayed waveform is within 0mV ±10mV. Refer to Figure 5-7 which shows well-adjusted waveform.



Note

Signal observed may be somewhat noisy. Adjust offset control so that signal is equally balanced around 0 volts dc.

Figure 5-7. Waveform at A5TP3.

5-21. A6 BOARD OFFSET ADJUSTMENT.

Service Sheet No. 6.

Note

This adjustment is affected by other adjustments. Refer to Section VIII paragraph 8-28 for troubleshooting if the adjustment fails to bring display to specified values.

DESCRIPTION:

These adjustments eliminate any residual dc offset voltage in the phase and zero detectors to minimize measurement errors. Except for the device to be connected to 4261A UNKNOWN terminals, no equipment is required for this adjustment.

PROCEDURE:

a. Set 4261A controls as follows:

FREQUENCY	1kHz
DC BIAS	OFF
TEST SIG LEVEL	1V
TRIGGER	INT
FUNCTION	L
CIRCUIT MODE	SER
RANGE HOLD	OFF

b. Short UNKNOWN terminals together (0Ω).

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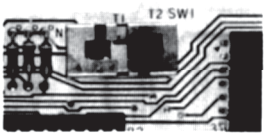
c. Set the slide switch on A8 Sequential Control Board Assembly (P/N 04261-77108) to TEST 2 as shown in Figure 5-8.

Note



Set the two slide switches to TEST(T2) as shown at right for A8 board P/N: 04261-77008.

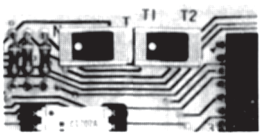


Figure 5-8. A8 Self Test Switch.

d. Set RANGE HOLD to ON (at any time).

e. Set OFFSET -4 potentiometer (A5R85) on A5 board (04261-77005) to its mid position.

f. Adjust ZERO OFFSET A6R68 for 1000 ±2 counts on 04261A LCR display.

g. Adjust PHASE OFFSET A6R67 for 0 to 2 counts on 4261A DISSIPATION FACTOR display.

h. Reset A8 Self Test Switch(es) to NORMAL position(s).

i. Change 4261A controls as follows:

FUNCTION C
CIRCUIT MODE ..... PARA
RANGE HOLD ..... OFF

j. Connect a 10nF standard capacitor to 4261A UNKNOWN terminals.

Note

Standard capacitor (10nF) used in step j and resistor (100kΩ) used in step m are listed in Table 4-1. HP 16361A provides these standard components.

k. Carefully adjust PHASE OFFSET A6R67 so that D display shows calibrated D value ±2 counts for the unknown component.

l. Change 4261A FUNCTION to R.

m. Replace unknown device with a 100kΩ resistor.

n. Carefully adjust ZERO OFFSET A6R68 so that R display shows calibrated value ±2 counts of unknown resistor.

5-22. A5 BOARD FINAL OFFSET ADJUSTMENT.
Service Sheet No. 5.

Note

Since this adjustment is affected by all above adjustments, it should always be done last. If any other adjustments are performed, this adjustment must be also be done (last). If adjustment fails to bring instrument into specified range, see Section VIII for troubleshooting.

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ADJUSTMENTS

DESCRIPTION:

This adjustment is the last of all 4261A adjustments used to bring the 4261A performance into specifications (per Table 1-1). This adjustment removes any residual offset voltage in the A5 board duty cycle adjustment circuit.

EQUIPMENT:

Oscilloscope ..... HP 180C/w 1801A/w 1821A

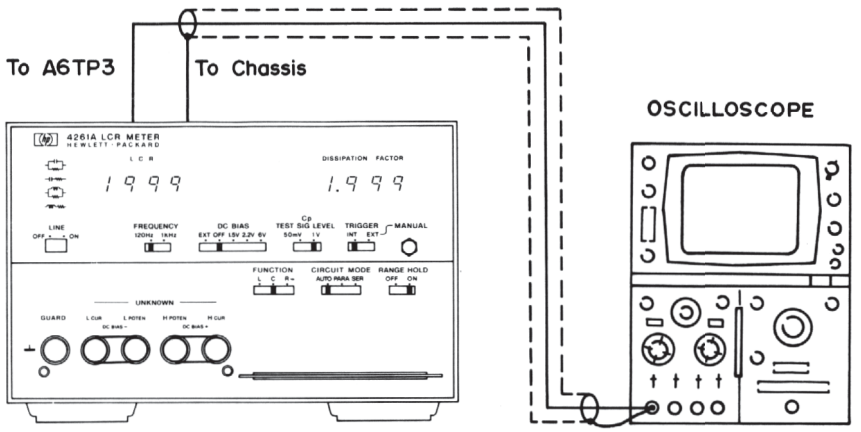

Figure 5-9. A5 Board Final Offset Adjustment.

PROCEDURE:

a. Connect BNC to alligator clip cable between oscilloscope and 4261A A6TP3 and 4261A chassis (see Figure 5-9).

b. Set 4261A controls as follows:

FREQUENCY	1kHz
DC BIAS	OFF
TEST SIG LEVEL	50mV
TRIGGER	INT
FUNCTION	C
CIRCUIT MODE	PARA
RANGE HOLD	OFF

c. Set oscilloscope voltage sensitivity to 0.5 volts/div. and sweep speed to 50 milliseconds/div..

d. Set input mode of oscilloscope to ground. Adjust position control of oscilloscope so that baseline is centered on CRT.

e. Set oscilloscope input mode to dc input. Set oscilloscope trigger mode to automatic.

f. Adjust OFFSET-4 A5R85 for a 0V ±1V dc level oscilloscope waveform display.

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5-23. CONFIRMATION CHECK.

The check in this paragraph confirms that adjustments in paragraphs 5-21 and 5-22 have been done satisfactorily.

a. Use same setup as in paragraph 5-22.

b. Set range of 4261A to 10.00nF range and RANGE HOLD to ON.

c. Connect a 1000pF standard capacitor to 4261A UNKNOWN terminals.

Note

Standard capacitor (1000pF) used here is listed in Table 4-1. HP 16361A provides this component.

d. Check that D display shows the calibrated D value for the capacitor within a tolerance of ± 2 counts.

If step d is unsatisfactory, repeat adjustments in paragraphs 5-21 and 5-23. If still unsatisfactory, refer to Section VIII troubleshooting.

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SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering parts. Table 6-1 lists abbreviations used in the parts list and throughout the manual. Table 6-3 lists all replaceable parts in reference designator order. Table 6-2 contains the names and addresses that correspond to the manufacturer's code numbers.

6-3. ABBREVIATIONS.

6-4. Table 6-1 lists abbreviations used in parts list, schematics and throughout the manual. In some cases, two forms of abbreviations are used, one in all capital letters, and one in partial capitals or no capitals. This occurs because the abbreviations in parts list are always all capitals. However, in the schematics and in other parts of the manual, other abbreviation forms with both lower case and upper case letters are used.

6-5. REPLACEABLE PARTS LIST.

6-6. Table 6-3 is a list of replaceable parts and is organized as follows:

a. Electrical assemblies and their components in alphanumerical order by reference designation.

b. Chassis-mounted parts in alphanumerical order by reference designation.

c. Miscellaneous parts.

d. Illustrated parts breakdowns, if appropriate.

The information for each part includes:

a. The Hewlett-Packard part number.

b. The total quantity (Qty) in the instrument.

Table 6-1. List of Reference Designators and Abbreviations

REFERENCE DESIGNATORS

A	= assembly	E	= misc electronic part	P	= plug	U	= integrated circuit
B	= motor	F	= fuse	Q	= transistor	V	= vacuum, tube, neon bulb, photocell, etc.
BT	= battery	FL	= filter	R	= resistor		
C	= capacitor	J	= jack	RT	= thermistor	VR	= voltage regulator
CP	= coupler	K	= relay	S	= switch	W	= cable
CR	= diode	L	= inductor	T	= transformer	X	= socket
DL	= delay line	M	= meter	TB	= terminal board	Y	= crystal
DS	= device signaling (lamp)	MP	= mechanical part	TP	= test point		

ABBREVIATIONS

A	= amperes	H	= henries	NPN	= negative-positive-negative	RWV	= reverse working voltage
A. F. C.	= automatic frequency control	HEX	= hexagonal	NRFR	= not recommended for field replacement		
AMPL	= amplifier	HG	= mercury	NSR	= not separately replaceable	S-B	= slow-blow
B. F. O.	= beat frequency oscillator	HR	= hour(s)			SCR	= screw
BE CU	= beryllium copper	Hz	= hertz			SE	= selenium
BH	= binder head	IF	= intermediate freq.	OBD	= order by description	SECT	= section(s)
BP	= bandpass	IMPG	= impregnated	OH	= oval head	SEMICON	= semiconductor
BRS	= brass	INCD	= incandescent	OX	= oxide	SI	= silicon
BWO	= backward wave oscillator	INCL	= include(s)			SIL	= silver
CCW	= counter-clockwise	INS	= insulation(ed)	P	= peak	SL	= slide
CER	= ceramic	INT	= internal	PC	= printed circuit	SPG	= spring
CMO	= cabinet mount only	k	= kilo = 1000	p	= pico = 10^{-12}	SPL	= special
COEF	= coefficient	LH	= left hand	PH BRZ	= phosphor bronze	SST	= stainless steel
COM	= common	LIN	= linear taper	PHL	= Phillips	SR	= split ring
COMP	= composition	LK WASH	= lock washer	PIV	= peak inverse voltage	STL	= steel
COMPL	= complete	LOG	= logarithmic taper	PNP	= positive-negative-positive		
CONN	= connector	LPF	= low pass filter	P/O	= part of	TA	= tantalum
CP	= cadmium plate	m	= milli = 10^{-3}	POLY	= polystyrene	TD	= time delay
CRT	= cathode-ray tube	M	= meg = 10^{6}	PORC	= porcelain	TGL	= toggle
CW	= clockwise	MET FLM	= metal film	POS	= position(s)	THD	= thread
DEPC	= deposited carbon	MET OX	= metallic oxide	POT	= potentiometer	TI	= titanium
DR	= drive	MFR	= manufacturer	PP	= peak-to-peak	TOL	= tolerance
ELECT	= electrolytic	MINAT	= miniature	PT	= point	TRIM	= trimmer
ENCAP	= encapsulated	MOM	= momentary	PWV	= peak working voltage	TWT	= traveling wave tube
EXT	= external	MTG	= mounting			μ	= micro = 10^{-6}
F	= farads	MY	= "mylar"	RECT	= rectifier	VAR	= variable
f	= femto = 10^{-15}	n	= nano = 10^{-9}	RF	= radio frequency	VDCW	= dc working volts
FH	= flat head	N/C	= normally closed	RH	= round head or right hand	W/	= with
FIL H	= fillister head	NE	= neon	RMO	= rack mount only	W	= watts
FXD	= fixed	NI PL	= nickel plate	RMS	= root-mean square	WIV	= working inverse voltage
G	= giga = 10^{9}	N/O	= normally open			WW	= wirewound
GE	= germanium	NPO	= negative positive zero (zero temperature coefficient)			W/O	= without
GL	= glass						
GRD	= ground(ed)						

0001-9700

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c. A description of the part.

d. A typical manufacturer of the part in a five-digit code.

e. The manufacturer's number for the part.

The total quantity for each part is given only once - at the first appearance of the part number in the list.

6-7. ORDERING INFORMATION.

6-8. To order a part listed in the replaceable parts table, give the Hewlett-Packard part number, indicate the quantity required, and address the order to the nearest Hewlett-Packard office.

6-9. To order a part that is not listed in the replaceable parts table, state the full instrument model and serial number, the description and function of the part, and the number of parts required. Address your order to the nearest Hewlett-Packard office.

6-10. SPARE PARTS KIT.

6-11. Stocking spare parts for an instrument is often done to insure quick return to service after a malfunction occurs. Hewlett-Packard has a Spare Parts Kit available for this purpose. The kit consists of selected replaceable assemblies and components for this instrument. The contents of the kit and the Recommended Spares List are based on failure reports and repair data, and parts support for one year. A complimentary Recommended Spares List for this instrument may be obtained on request and the Spare Parts Kit may be ordered through your nearest Hewlett-Packard office.

6-12. DIRECT MAIL ORDER SYSTEM.

6-13. Within the USA, Hewlett-Packard can supply parts through a direct mail order system. Advantages of using the system are:

a. Direct ordering and shipment from the HP Parts Center in Mountain View, California.

b. No maximum or minimum on any mail order (there is a minimum order amount for parts ordered through a local HP Office when the orders require billing and invoicing).

c. Prepaid transportation (there is a small handling charge for each order).

d. No invoices - to provide these advantages, a check or money order must accompany each order.

6-14. Mail order forms and specific ordering information is available through your local HP Office. Addresses and phone numbers are located at the back of this manual.

Table 6-2. Manufacturers Code List.

MFR NO.	MANUFACTURER NAME	ADDRESS	ZIP CODE
00779	AMP INC	HARRISBURG PA	17105
01121	ALLEN-BRADLEY CO	MILWAUKEE WI	53212
01295	TEXAS INSTR INC SEMICOND CMPNT DIV	DALLAS TX	75231
02735	RCA CORP SOLID STATE DIV	SOMMERVILLE NJ	08876
02768	ILLINOIS TOOL WORKS INC FASTEX DIV	DES PLAINES IL	60016
03888	KDI PYROFILM CORP	WHIPPANY NJ	07981
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX AZ	85008
04866	NYLOK-DETROIT CORP	TROY MI	48084
07088	KELVIN ELECTRIC CO	VAN NUYS CA	91401
07263	FAIRCHILD SEMICONDUCTOR DIV	MOUNTAIN VIEW CA	94040
10389	CHICAGO SWITCH INC	CHICAGO IL	60647
12697	CLAROSTAT MFG CO INC	DOVER NH	03820
16299	CORNING GL WK ELEC CMPNT DIV	RALEIGH NC	27604
19701	MEPCO/ELECTRA CORP	MINERAL WELLS TX	76067
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD PA	16701
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA CA	95051
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO CA	94304
30983	MEPCO/ELECTRA CORP	SAN DIEGO CA	92121
50522	MONSANTO CO ELEK SPECIAL PROD	CUPERTINO CA	95014
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS MA	01247
71785	TRW ELEK COMPONENTS CINCH DIV	ELK GROVE VILLAGE IL	60007
72136	ELECTRO MOTIVE MFG CO INC	WILLIMANTIC CT	06226
72962	ELASTIC STOP NUT DIV OF AMERACE	UNION NJ	07083
73734	FEDERAL SCREW PRODUCTS CO	CHICAGO IL	60618
73743	FISCHER SPECIAL MFG CO	CINCINNATI OH	45206
75042	TRW INC PHILADELPHIA DIV	PHILADELPHIA PA	19108
75915	LITTELFUSE INC	DES PLAINES IL	60016
76381	3M COMPANY	ST PAUL MN	55101
78189	ILLINOIS TOOL WORKS INC SHAKEPROOF	ELGIN IL	60126
79727	C-W INDUSTRIES	WARMINSTER PA	18974
79963	ZIERICK MFG CO	MT KISCO NY	10549
80120	SCHNITZER ALLOY PRODUCTS CO	ELIZABETH NJ	07206
80126	PACIFIC ELECTRICORD CO	GARDENA CA	90247
81073	GRAYHILL INC	LA GRANGE IL	60525
82389	SWITCHCRAFT INC	CHICAGO IL	60630
9D949	AMPHENOL SALES DIV OF BUNKER-RAMO	HAZELWOOD MO	63042
93790	NO M/F DESCRIPTION FOR THIS MFG NUMBER		

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	04261-77001	1	SWITCH BOARD ASSEMBLY	28480	04261-77001
A1S1	5060-4801	4	SLIDE SWITCH ASSEMBLY (FREQUENCY)	28480	5060-4801
A1S2	5060-4801		SLIDE SWITCH ASSEMBLY (DC BIAS)	28480	5060-4801
A1S3	5060-4801		SLIDE SWITCH ASSEMBLY (Cp TEST SIG LEVEL)	28480	5060-4801
A1S4	5060-4801		SLIDE SWITCH ASSEMBLY (TRIGGER)	28480	5060-4801
A1S5	3101-1074	1	SWITCH-PB SPST NO MOM 1A 115VAC (MANUAL)	81073	30-3
A1S6	5060-4802	3	SLIDE SWITCH ASSEMBLY (FUNCTION)	28480	5060-4802
A1S7	5060-4802		SLIDE SWITCH ASSEMBLY (CIRCUIT MODE)	28480	5060-4802
A1S8	5060-4802		SLIDE SWITCH ASSEMBLY (RANGE HOLD)	28480	5060-4802
A1W1	8120-0352	1	CABLE ASSEMBLY		
			A1 MISCELLANEOUS		
	5020-3440	7	SPRING, DETENT	28480	5020-3440
	04261-30021	1	BAR (131 MM)	28480	04261-30021
	04261-30022	1	BAR (148 MM)	28480	04261-30022
	04261-30023	1	BAR (95 MM)	28480	04261-30023
A2	04261-77002	1	DISPLAY BOARD ASSEMBLY	28480	04261-77002
A2DS1	1990-0452	2	DISPLAY NUM SEG 1 CHAR .3 IN HIGH	28480	1990-0452
A2DS2	1990-0434	6	DISPLAY NUM SEG 1 CHAR .3 IN HIGH	28480	1990-0434
A2DS3	1990-0434		DISPLAY NUM SEG 1 CHAR .3 IN HIGH	28480	1990-0434
A2DS4	1990-0434		DISPLAY NUM SEG 1 CHAR .3 IN HIGH	28480	1990-0434
A2DS5	1990-0452		DISPLAY NUM SEG 1 CHAR .3 IN HIGH	28480	1990-0452
A2DS6	1990-0434		DISPLAY NUM SEG 1 CHAR .3 IN HIGH	28480	1990-0434
A2DS7	1990-0434		DISPLAY NUM SEG 1 CHAR .3 IN HIGH	28480	1990-0434
A2DS8	1990-0434		DISPLAY NUM SEG 1 CHAR .3 IN HIGH	28480	1990-0434
A2DS9	1990-0517	17	OPTO-ISOLATOR LED-PXSTR	50522	MCA2-30
A2DS10	1990-0517		OPTO-ISOLATOR LED-PXSTR	50522	MCA2-30
A2DS11	1990-0517		OPTO-ISOLATOR LED-PXSTR	50522	MCA2-30
A2DS12	1990-0517		OPTO-ISOLATOR LED-PXSTR	50522	MCA2-30
A2DS13	1990-0517		OPTO-ISOLATOR LED-PXSTR	50522	MCA2-30
A2DS14	1990-0517		OPTO-ISOLATOR LED-PXSTR	50522	MCA2-30
A2DS15	1990-0517		OPTO-ISOLATOR LED-PXSTR	50522	MCA2-30
A2DS16	1990-0517		OPTO-ISOLATOR LED-PXSTR	50522	MCA2-30
A2DS17	1990-0517		OPTO-ISOLATOR LED-PXSTR	50522	MCA2-30
A2DS18	1990-0517		OPTO-ISOLATOR LED-PXSTR	50522	MCA2-30
A2DS19	1990-0517		OPTO-ISOLATOR LED-PXSTR	50522	MCA2-30
A2DS20	1990-0517		OPTO-ISOLATOR LED-PXSTR	50522	MCA2-30
A2DS21	1990-0517		OPTO-ISOLATOR LED-PXSTR	50522	MCA2-30
A2DS22	1990-0517		OPTO-ISOLATOR LED-PXSTR	50522	MCA2-30
A2DS24	1990-0517		OPTO-ISOLATOR LED-PXSTR	50522	MCA2-30
A2DS25	1990-0517		OPTO-ISOLATOR LED-PXSTR	50522	MCA2-30
A2J1 thru J8	1200-0638		SOCKET 14 CONT		
A2R1	0683-2715	37	RESISTOR 270 5% .25W		
A2R2	0683-2715		RESISTOR 270 5% .25W		
A2R3	0683-2715		RESISTOR 270 5% .25W		
A2R4	0683-2715		RESISTOR 270 5% .25W		
A2R5	0683-2715		RESISTOR 270 5% .25W		
A2R6	0683-2715		RESISTOR 270 5% .25W		
A2R7	0683-1515	4	RESISTOR 150 5% .25W		
A2R8	0683-1015		RESISTOR 100 5% .25W	01121	CB1015
A2R9	0683-2715		RESISTOR 270 5% .25W		
A2R10	0683-2715		RESISTOR 270 5% .25W		
A2R11	0683-2715		RESISTOR 270 5% .25W		
A2R12	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R13	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R14	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R15	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R16	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+500		
A2R17	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+500		
A2R18	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+500		
A2R19	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+500		
A2R20	0683-2715		RESISTOR 270 5% .25W		
A2R21	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R22	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R23	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+500		
A2R24	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R25	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R26	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R27	0683-1515		RESISTOR 150 5% .25W FC TC=-400/+600	01121	CB1515
A2R28	0683-1515		RESISTOR 150 5% .25W FC TC=-400/+600	01121	CB1515
A2R29	0683-1515		RESISTOR 150 5% .25W FC TC=-400/+600	01121	CB1515
A2R30	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+500		

See introduction to this section for ordering information

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Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2R31	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+500		
A2R32	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R33	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R34	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R35	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2W1	8120-0355	3	CABLE ASSEMBLY		
A2W2	8120-0355		CABLE ASSEMBLY		
A2W3	8120-0355		CABLE ASSEMBLY		
			A2 MISCELLANEOUS		
	0520-0127	2	SCREW-MACH 2-56 .188-IN-LG PAN-HD-POZI	28480	0520-0127
	04261-10029	1	ANGLE	28480	04261-10029
	04261-40025	1	SPACER FOR LED LAMP		
	04261-40026	1	SPACER FOR LED LAMP		
	04261-40027	1	SPACER FOR LED LAMP		
	04261-85024	1	LABEL, INFORMATION	28480	04261-85024
A3	04261-77103	1	DECODER BOARD ASSEMBLY	28480	04261-77103
A3C1	0180-0374	7	CAPACITOR-FXD 10UF +-10% 20VDC TA	56289	150D106X9020B2
A3C2	0180-0374		CAPACITOR-FXD 10UF +-10% 20VDC TA	56289	150D106X9020B2
A3C3	0180-0197	3	CAPACITOR-FXD 2.2UF +-10% 20VDC TA	56289	150D225X9020A2
A3C4	0160-2055	28	CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A3C5	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A3C6	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A3C7	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WDDC CER	28480	0160-2055
A3C8	0180-0374		CAPACITOR-FXD 10UF +-10% 20VDC TA	56289	150D106X9020B2
A3J1	1200-0853		SOCKET-IC 16-CONT DIP-SLDR-TERMS		
A3J2	1200-0853		SOCKET-IC 16-CONT DIP-SLDR-TERMS		
A3J3	1200-0853		SOCKET-IC 16-CONT DIP-SLDR-TERMS		
A3J4	1200-0613	4	SOCKET, ELEC, IC 28-CONT DIP SLDR TERM	28480	1200-0613
A3Q1	1854-0071	19	TRANSISTOR NPN SI PD=300MW FT=200MHz	28480	1854-0071
A3Q2	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHz	28480	1854-0071
A3Q3	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHz	28480	1854-0071
A3Q4	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHz	28480	1854-0071
A3R1	1810-0164	5	NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0164
A3R2	1810-0164		NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0164
A3R3	1810-0164		NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0164
A3R4	0683-1025	33	RESISTOR 1k 5% .25W FC TC=400/+600	01121	CB1025
A3R5	0683-1025		RESISTOR 1k 5% .25W FC TC=400/+600	01121	CB1025
A3R6	0683-1025		RESISTOR 1k 5% .25W FC TC=400/+600	01121	CB1025
A3R7	0683-1025		RESISTOR 1k 5% .25W FC TC=400/+600	01121	CB1025
A3R8	0683-1025		RESISTOR 1k 5% .25W FC TC=400/+600	01121	CB1025
A3R9	0698-4431		RESISTOR 2.05k 1%		
A3R10	0757-0442		RESISTOR 10k 1% .125W		
A3U1	1820-1688	2	IC:SN74LS247 BCD TO 7-SEGMENT DECODER	28480	1820-1688
A3U2	1820-1688		IC:SN74LS247 BCD TO 7-SEGMENT DECODER	28480	1820-1688
A3U3	1820-0471	4	IC SN74 06 N INV	01295	SN7406N
A3U4	1820-1411	4	IC SN74LS 75 N LATCH	01295	SN74LS75N
A3U5	1820-0471		IC SN74 06 N INV	01295	SN7406N
A3U6	1820-1411		IC SN74LS 75 N LATCH	01295	SN74LS75N
A3U7	1820-0471		IC SN74 06 N INV	01295	SN7406N
A3U8	1820-1436	2	IC SN74LS170 N DIGITAL	01295	SN74LS170N
A3U9	1820-1436		IC SN74LS170 N DIGITAL	01295	SN74LS170N
A3U10	1820-1199	5	IC SN74LS 04 N INV	01295	SN74LS04N
A3U11	1820-1411		IC SN74LS 75 N LATCH	01295	SN74LS75N
A3U12	1820-1411		IC SN74LS 75 N LATCH	01295	SN74LS75N
A3U13	1820-1197	8	IC SN74LS 00 N GATE	01295	SN74LS00N
A3U14	1820-1199		IC SN74LS 04 N INV	01295	SN74LS04N
A3U15	1820-1144	2	IC SN74LS 02 N GATE	01295	SN74LS02N
A3U16	1820-0902	2	IC SN75 450AN DRIVER	01295	SN75450AN
A3U17	1820-0902		IC SN75 450AN DRIVER	01295	SN75450AN
A3U18	1818-2271	1	IC, R.O.M.	28480	1818-2271
A4	04261-77004	1	OSCILLATOR/RANGE RESISTOR BOARD ASSEMBLY	28480	04261-77004
A4C1	0160-1670	3	CAPACITOR-FXD 10000pF .5%	28480	0160-1670
A4C2	0160-1670		CAPACITOR-FXD 10000pF .5%	28480	0160-1670
A4C3	0180-0228	2	CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A4C4	0180-0228		CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A4C5	0180-1052	4	CAPACITOR-FXD 220UF 6.3V	28480	0180-1052
A4C6	0180-1051	16	CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4C7	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4C8	0180-1052		CAPACITOR-FXD 220UF 6.3V	28480	0180-1052
A4C9	0180-1056	3	CAPACITOR:FXD 1000 UF 25VDC AL ELECT	28480	0180-1056
A4C10			NOT ASSIGNED		

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Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
*A4C11	0160-2202	1	CAPACITOR-FXD 75pF +-5% 300WVDC MICA	28480	0160-2202
A4C12	0160-2307	1	CAPACITOR-FXD 47pF +-5% 300WVDC MICA	28480	0160-2307
A4C13	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4C14	0160-2264	1	CAPACITOR-FXD 20pF +-5% 500WVDC CER	28480	0160-2264
A4C15	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4C16	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4C17	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4C18	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4C19	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4CR1	1901-0040	42	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR2	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR3	1902-3037	1	DIODE-ZNR 3.16V 2% DO-7 PD=.4W TC=-.064%	04713	
A4CR4	1902-0554	1	DIODE-ZNR 10V 5% DO-7 PD=1W		
A4CR5	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR6	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR7	1902-0845		DIODE-ZNR 11V 5% PD=1W TC=+.07%	28480	RD11FB
A4CR8	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR9	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR10	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR11	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR12	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR13	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR14	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR15	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR16	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR17	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR18	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR19	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR20	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR21	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR22	1902-3149	5	DIODE-ZNR 9.09V 5% DO-7 PD=.4W TC=+.057%	04713	SZ 10939-170
A4CR23	1902-0845	2	DIODE-ZNR 11V 5% PD=1W TC=+-.07%	28480	RD11FB
A4CR24	1902-0845		DIODE-ZNR 11V 5% PD=1W TC=+-.07%	28480	RD11FB
A4CR25	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR26	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR27	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR28	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4K1	0490-0226		RELAY:REED		
A4K2	0490-0234		RELAY:REED		
A4K3	0490-0234		RELAY:REED		
A4K4	0490-0234		RELAY:REED		
A4Q1	1855-0062	8	TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0062
A4Q2	5080-3830	21	TRANSISTOR J-FET N-CHAN D-MODE SI		
A4Q3	1855-0082	1	TRANSISTOR MOSFET P-CHAN D-MODE SI	28480	1855-0082
A4Q4	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHz	28480	1854-0071
A4Q5	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHz	28480	1854-0071
A4Q6	1853-0020	24	TRANSISTOR PNP SI PD=300MW FT=150MHz	28480	1853-0020
A4Q7	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHz	28480	1853-0020
A4Q8	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHz	28480	1854-0071
A4Q9	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHz	28480	1853-0020
A4Q12	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHz	28480	1854-0071
A4Q13	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHz	28480	1854-0071
A4Q14	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHz	28480	1854-0071
A4Q15	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHz	28480	1854-0071
A4Q16	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHz	28480	1854-0071
A4Q17	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHz	28480	1854-0071
A4Q18	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHz	28480	1854-0071
A4Q19	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHz	28480	1854-0071
A4Q20	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A4Q21	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A4Q22	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A4Q23	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A4Q24	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A4Q25	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A4Q26	1855-0128	1	TRANSISTOR J-FET N-CHAN E-108	28480	1855-0128
A4Q27	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A4Q28	1854-0013	1	TRANSISTOR NPN 2N2218A SI TO-5 PD=800MW	04713	2N2218A
A4Q29	1853-0012	1	TRANSISTOR PNP 2N2904A SI TO-5 PD=600MW	01295	2N2904A
A4Q30	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHz	28480	1853-0020
A4Q31	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHz	28480	1853-0020
A4Q32	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHz	28480	1853-0020
A4Q33	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHz	28480	1853-0020
A4Q34	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHz	28480	1853-0020
A4R1	0757-0486	2	RESISTOR 750k 1% .125W F TC=0+-100	24546	NA4
A4R2	0698-3136	1	RESISTOR 17.8k 1% .125W F TC=0+-100	16299	C4-1/8-T0-1782-F
A4R3	0757-0486		RESISTOR 750k 1% .125W F TC=0+-100	24546	NA4
A4R4	0757-0448	1	RESISTOR 18.2k 1% .125W F TC=0+-100	24546	C4-1/8-T0-1822-F
A4R5	0698-3451	2	RESISTOR 133k 1% .125W F TC=0+-100	16299	C4-1/8-T0-1333-F

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Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4R6	0698-3451		RESISTOR 133K 1% .125W F TC=0+-100	16299	C4-1/8-T0-1333-F
A4R7	0757-0317	2	RESISTOR 1.33K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1331-F
A4R8	0757-0278	1	RESISTOR 1.78K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1781-F
A4R9	0698-3155	4	RESISTOR 4.64K 1% .125W F TC=0+-100	16299	C4-1/8-T0-4641-F
A4R10	0683-3335	38	RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R11	0683-8225	1	RESISTOR 8.2K 5% .25W FC TC=-400/+700	01121	CB8225
A4R12	0698-3154	1	RESISTOR 4.22K 1% .125W F TC=0+-100	16299	C4-1/8-T0-4221-F
A4R13	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R14	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+800	01121	CB3335
A4R15	0757-0443	1	RESISTOR 11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1102-F
A4R16	0757-0416	3	RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A4R17	0698-4442	1	RESISTOR 4.42K 1% .125W F TC=0+-100	16299	C4-1/8-T0-4421-F
A4R18	0698-4420	1	RESISTOR 226 1% .125W F TC=0+-100	16299	C4-1/8-T0-226R-F
A4R19	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R20	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R21	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R22	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R23	0683-4725	43	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A4R24	0683-7525	1	RESISTOR 7.5K 5% .25W FC TC=-400/+700	01121	CB7525
A4R25	0757-0442	4	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A4R26	0698-3515	1	RESISTOR 5.90K 1% .125W F TC=0+-100	16299	C4-1/8-T0-5901-F
A4R27	0683-1535	3	RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A4R28	0683-1535		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A4R29	0683-0275	4	RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	CB27G5
A4R30	0683-0275		RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	CB27G5
A4R31	0764-0015	1	RESISTOR 560 5% 2W MO TC=0+-200	24546	FP42-2-T00-561-J
A4R32	0757-0465	4	RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A4R33	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A4R35	0698-0083	2	RESISTOR 1.96K 1% .125W F TC=0+-100	16299	C4-1/8-T0-1961-F
A4R37	0698-3440	2	RESISTOR 196 1% .125W F TC=0+-100	16299	C4-1/8-T0-196R-F
A4R38	0698-3440		RESISTOR 196 1% .125W F TC=0+-100	16299	C4-1/8-T0-196R-F
A4R39	0683-0825	1	RESISTOR 8.2 5% .25W FC TC=-400/+500	01121	CB82G5
A4R40	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R41	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R42	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R43	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R44	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R45	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R46	0683-3335	6	RESISTOR 33k 5% .25W FC TC=-400/+800	01121	CB3335
A4R47	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R50	0683-5625	1	RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625
A4R51	0683-2215	2	RESISTOR 220 5% .25W FC TC=-400/+700	01121	
A4R52	0698-2225	1	RESISTOR:FXD 90.0K OHM 0.05% .1/8W MF	28480	0698-2225
A4R53	0698-2295	1	RESISTOR:FXD 11.090 OHM 0.05%	28480	0698-2295
A4R54	0698-3329	1	RESISTOR 10K .5% .125W F TC=0+-100	03888	PME55-1/8-T0-1002-D
A4R55	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A4R56	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A4R57	0698-2296	1	RESISTOR:FXD 1010.1 OHM 0.05%	28480	0698-2296
A4R58	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A4R59	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A4R60	0698-2294	1	RESISTOR:FXD 100.10HM 0.05%	28480	0698-2294
A4R61	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A4R62	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A4R63	0698-2298	1	RESISTOR:FXD 10 OHM 0.05%	28480	0698-2298
A4R64	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A4R65	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A4R66	0683-4705	2	RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A4R67	0683-4705		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A4R68	0683-1035	11	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A4R69	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A4R70	0757-1090	2	RESISTOR 261 1% .5W F TC=0+-100	19701	MF7C1/2-T0-261R-F
A4R71	0683-0275		RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	CB27G5
A4R72	0683-0275		RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	CB27G5
A4R73	0757-1090		RESISTOR 261 1% .5W F TC=0+-100	19701	MF7C1/2-T0-261R-F
A4R74	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R75	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R76	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R77	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R78	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335

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Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4R79	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R80	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R81	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R82	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R83	0683-3335		RESISTOR 33k 5% .25W FC TC=-400/+800	01121	CB3335
A4R84	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R85	0698-0083		RESISTOR 1.96k 1% .125W F TC=0+-100	16299	C4-1/8-T0-1961-F
A4R86	0683-1065	1	RESISTOR 10M 5% .25W FC TC=-900/+1000	01121	CB1065
A4R87	2100-2514	1	RESISTOR-TRMR 20k 10% C SIDE-ADJ 1-TURN	30983	ET50W203
A4T1	9100-0846	1	TRANSFORMER-PULSE 412N3	28480	9100-0846
A4U1	1826-0139	6	IC MC 1458 OP AMP	04713	MC1458P1
A4U2	1826-0013	1	IC OP AMP	28480	1826-0013
	04261-50022	1	SUPPORTER, BOARD	28480	04261-50022
A5	04261-77005	1	PROCESS AMPLIFIER BOARD ASSEMBLY	28480	04261-77005
A5C1	0160-1678	3	C:FXD MY 0.1 UF 2% 200VDCW	28480	0160-1678
A5C2	0160-2254	1	CAPACITOR-FXD 7.5PF +-.25PF 500WVDC CER	28480	0160-2254
A5C3	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	93790	RDM15F101J3C
A5C4	0160-1678		C:FXD MY 0.1 UF 2% 200VDCW	28480	0160-1678
A5C5	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	93790	RDM15F101J3C
A5C6	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A5C7	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A5C8	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A5C9	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A5C10	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A5C11	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A5C12	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A5C13	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A5C14	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A5C15	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A5C16	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A5C17	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A5C18	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A5C19	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A5C20	0140-0190		CAPACITOR-FXD 39pF MICA		
A5CR1	1901-0376	6	DIODE-GEN PRP	28480	1901-0376
A5CR2	1901-0376		DIODE-GEN PRP	28480	1901-0376
A5CR4	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR5	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR6	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR7	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR8	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR9	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR10	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR11	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR12	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR13	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR14	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR16	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR18	1902-0041	5	DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=-.009%	04713	SZ 10939-98
A5CR19	1902-0041		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=-.009%	04713	SZ 10939-98
A5CR20	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR21	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR22	1902-0049	3	DIODE-ZNR 6.19V 5% DO-7 PD=.4W TC=+.022%	04713	SZ 10939-122
A5Q1	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A5Q2	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A5Q3	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A5Q4	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A5Q5	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A5Q7	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A5Q8	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A5Q9	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A5Q10	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A5Q11	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A5Q12	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A5Q13	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A5Q14	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A5Q15	1855-0062		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0062
A5Q17	1855-0062		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0062
A5Q19	1855-0062		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0062
A5Q20	1855-0062		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0062

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Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A5R1	0683-1025		RESISTOR 1k 5% .25W FC TC=-400/+600	01121	CB1025
A5R2	0683-2235	18	RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235
A5R3	0683-1235	3	RESISTOR 12k 5% .25W FC TC=-400/+800	01121	CB1235
A5R4	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235
A5R5	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235
A5R6	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235
A5R7	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235
A5R8	0683-1235		RESISTOR 12k 5% .25W FC TC=-400/+800	01121	CB1235
A5R9	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235
A5R10	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235
A5R11	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235
A5R12	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235
A5R15	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235
A5R17	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235
A5R18	0683-1235		RESISTOR 12k 5% .25W FC TC=-400/+800	01121	CB1235
A5R19	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235
A5R20	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235
A5R21	0683-2235		RESISTOR 22k 5% .25W FC TC=-400/+800	01121	CB2235
A5R22	0698-8827		RESISTOR 1M OHM 1% .25W		
A5R23	0683-1035		RESISTOR 10k 5% .25W FC TC=-400/+700	01121	CB1035
A5R24	0698-2297	4	RESISTOR:FXD 3.01k OHM 0.05%	28480	0698-2297
A5R25	0698-2297		RESISTOR:FXD 3.01k OHM 0.05%	28480	0698-2297
A5R26	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A5R27	0757-0273	4	RESISTOR 3.01K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3011-F
A5R28	0757-0273		RESISTOR 3.01K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3011-F
A5R29	0683-5645	4	RESISTOR 560K 5% .25W FC TC=-800/+900	01121	
A5R31	2100-2516	4	RESISTOR-TRMR 100K 10% C SIDE-ADJ 1-TURN	30983	ET50X104
A5R32	0698-8827		RESISTOR 1M 1% .25W FC TC=-800/+900		
A5R33	0698-2297		RESISTOR:FXD 3.01k OHM 0.05%	28480	0698-2297
A5R34	0698-2297		RESISTOR:FXD 3.01k OHM 0.05%	28480	0698-2297
A5R35	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A5R36	0757-0273		RESISTOR 3.01K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3011-F
A5R37	0757-0273		RESISTOR 3.01K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3011-F
A5R38	0683-5645		RESISTOR 560K 5% .25W FC TC=-800/+900	01121	
A5R40	2100-2516		RESISTOR-TRMR 100K 10% C SIDE-ADJ 1-TURN	30983	ET50X104
A5R41	0698-2207	2	RESISTOR:FXD 900 OHM 0.05% 1/8W MF	28480	0698-2207
A5R42	0698-2206	2	RESISTOR:FXD 100 OHM 0.05% 1/8W MF	28480	0698-2206
A5R43	0698-2207		RESISTOR:FXD 900 OHM 0.05% 1/8W MF	28480	0698-2207
A5R44	0698-2206		RESISTOR:FXD 100 OHM 0.05% 1/8W MF	28480	0698-2206
A5R45	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A5R46	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A5R47	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A5R48	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A5R49	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A5R50	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A5R51	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R52	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A5R53	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A5R54	2100-2516		RESISTOR-TRMR 100K 10% C SIDE-ADJ 1-TURN	30983	ET50X104
A5R55	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R56	0683-2235		RESISTOR 22K 5% .25W FC TC=-400/+800	01121	CB2235
A5R57	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A5R59	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R60	0683-2235		RESISTOR 22K 5% .25W FC TC=-400/+800	01121	CB2235
A5R61	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A5R63	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R64	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A5R65	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R66	0683-3935	1	RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A5R67	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A5R68	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R69	0683-2235		RESISTOR 22K 5% .25W FC TC=-400/+800	01121	CB2235
A5R70	0683-1825	10	RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A5R71	0683-1825		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A5R72	0683-2235		RESISTOR 22K 5% .25W FC TC=-400/+800	01121	CB2235
A5R73	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R74	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A5R75	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R76	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A5R77	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A5R78	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A5R79	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A5R80	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A5R81	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015

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Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A5R82	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A5R83	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A5R84	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A5R85	2100-2516		RESISTOR-TRMR 100K 10% C SIDE-ADJ 1-TURN	30983	ET50X104
A5R86	0683-4725		RESISTOR 4.7K 5% .25W		
A5U1	5080-3069	2	IC LF356H OP AMP		LF356H
A5U2	1826-0217	2	IC RAY 4558T OP AMP		
A5U3	1826-0319		IC LF356H OP AMP		LF356H
A5U4	1826-0217		IC RAY 4558T OP AMP		
A5U5	1826-0139		IC MC 1458 OP AMP	04713	MC1458P1
A5U6	1826-0139		IC MC 1458 OP AMP	04713	MC1458P1
A5U7	1820-0125	1	IC UA 711C COMPARATOR	07263	711HC
A5U8	1820-0321	2	IC UA 710C COMPARATOR	07263	710HC
A6	04261-77006 04261-66906	1	PHASE DETECTOR/INTEGRATOR BOARD ASSEMBLY OPT. 010	28480	04261-77006
A6C1	0160-1586		C:FXD MY 0.1 UF 10% 100VDCW	28480	0160-1586
A6C2	0160-0207	2	C:FXD MY 0.01 UF 5% 200VDCW	28480	0160-0207
A6C3	0160-1670		CAPACITOR-FXD 10000pF 0.05%	28480	0160-1670
A6C4	0160-0127	2	CAPACITOR-FXD 1UF +-20% 25WVDC CER	28480	0160-0127
A6C5	0180-1052		CAPACITOR-FXD 220UF 6.3V	28480	0180-1052
A6C6	0160-0127		CAPACITOR-FXD 1UF +-20% 25WVDC CER	28480	0160-0127
A6C7	0180-1052		CAPACITOR-FXD 220UF 6.3V	28480	0180-1052
A6C8	0160-0040	2	C:FXD MY 0.047 UF 5% 200VDCW	28480	0160-0040
A6C9	0160-0040		C:FXD MY 0.047 UF 5% 200VDCW	28480	0160-0040
A6C10	0160-1587	1	C:FXD MY.33UF 5%	28480	0160-1587
	0160-1563		C:FXD MY.47UF 5% (OPT. 010)		
A6C11	0160-0207		C:FXD MY 0.01 UF 5% 200VDCW	28480	0160-0207
A6C12	0160-1603	1	C:FXD MY 1 UF 10% 100VDCW	28480	0160-1603
A6C13	0160-1674	2	C:FXD MY 0.33 UF 10%	28480	0160-1674
A6C14	0160-1554		C:FXD MY 0.33 UF 5% 200VDCW	28480	0160-1554
A6C15	0160-2055	4	CAPACITOR-FXD .01UF +80-20% 100WVDC CER		
A6C16	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER		
A6C17	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER		
A6C18	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER		
A6C19	0180-0197		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A6C20	0180-0197		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A6C21	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A6C22	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A6C23	0150-0075		CAPACITOR-FXD 0.0047UF 500V	28480	0150-0075
A6C24	0160-0763		CAPACITOR-FXD 5pF		0160-0763
A6C25	0160-2197		CAPACITOR-FXD 10pF 5% 300WVDC MICA		0160-2197
A6CR1	1902-3125	1	DIODE-ZNR 6.98V 2% DO-7 PD=.4W TC=+.045%	04713	SZ 10939-138
A6CR2	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR3	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR4	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR5	1902-3074	1	DIODE-ZNR 4.32V 2% DO-7 PD=.4W TC=-.035%	04713	SZ 10939-78
	1902-3083		DIODE-ZNR 4.64V 2% (OPT. 010)		
A6CR6	1902-3149		DIODE-ZNR 9.09V 5% DO-7 PD=.4W TC=+.057%	04713	SZ 10939-170
A6CR7	1902-3149		DIODE-ZNR 9.09V 5% DO-7 PD=.4W TC=+.057%	04713	SZ 10939-170
A6CR8	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR9	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR10	1902-3149		DIODE-ZNR 9.09V 5% DO-7 PD=.4W TC=+.057%	04713	SZ 10939-170
A6CR11	1902-0049		DIODE-ZNR 6.19V 5% DO-7 PD=.4W TC=+.022%	04713	SZ 10939-122
A6CR12	1902-3059	1	DIODE-ZNR 3.83V 5% DO-7 PD=.4W TC=-.051%	04713	SZ 10939-62
A6CR13	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR14	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR15	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR16	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR17	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR18	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR19	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR20	1902-0049		DIODE-ZNR 6.19V 5% DO-7 PD=.4W TC=+.022%	04713	SZ 10939-122
A6Q1	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A6Q2	1854-0023		TRANSISTOR NPN SI PD=360MW	28480	1854-0023
A6Q3	1853-0034		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0034
A6Q4	1853-0034		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0034
A6Q5	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A6Q6	1855-0081		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
A6Q7	1855-0081		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
A6Q8	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A6Q9	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A6Q10	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A6Q11	1855-0081	1	TRANSISTOR J-FET N-CHAN	28480	1855-0081
A6Q12	1855-0119	3	TRANSISTOR J-FET	28480	1855-0119
A6Q13	1855-0062		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0062
A6Q14	1855-0062		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0062
A6Q15	1855-0119		TRANSISTOR J-FET	28480	1855-0119
A6Q16	1855-0119		TRANSISTOR J-FET	28480	1855-0119
A6Q17	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A6Q18	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A6Q19	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A6Q20	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020

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Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A6Q21	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A6Q22	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A6Q23	5080-3830		TRANSISTOR J-FET N-CHAN D-MODE SI		
A6Q24	1855-0049	1	TRANSISTOR-JFET DUAL N-CHAN D-MODE SI	28480	1855-0049
A6Q25	1855-0062		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0062
A6R1	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A6R2	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A6R3	0698-3226	3	RESISTOR 6.49K 1% .125W F TC=0+-100	16299	C4-1/8-T0-6491-F
A6R4	0698-3226		RESISTOR 6.49K 1% .125W F TC=0+-100	16299	C4-1/8-T0-6491-F
A6R5	0683-4745	1	RESISTOR 470K 5% .25W	01121	
A6R6	0698-3161	1	RESISTOR 38.3K 1% .125W F TC=0+-100	16299	C4-1/8-T0-3832-F
A6R7	0757-0416		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A6R8	0757-0416		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A6R9	0757-0435	1	RESISTOR 3.92K 1% .125W	16299	
A6R10	0698-3226		RESISTOR 6.49K 1% .125W F TC=0+-100	16299	C4-1/8-T0-6491-F
A6R11	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A6R12	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A6R13	0683-1225		RESISTOR 1.2K 5% .25W		
A6R14	0683-3925	2	RESISTOR 3.9K 5% .25W FC TC=-400/+700	01121	CB3925
A6R15	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A6R16	0683-1225		RESISTOR 1.2K 5% .25W		
A6R17	0683-3925		RESISTOR 3.9K 5% .25W FC TC=-400/+700	01121	CB3925
A6R18	0683-2225		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A6R19	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A6R20	0698-3439	1	RESISTOR 178 1% .125W F TC=0+-100	16299	C4-1/8-T0-178R-F
A6R21	0698-4157	2	RESISTOR 10K .1% .125W F TC=0+-50	24546	NC55
A6R22	0698-4157		RESISTOR 10K .1% .125W F TC=0+-50	24546	NC55
A6R23	0698-6943	2	RESISTOR 20K .1% .125W F TC=0+-50	24546	NC55
A6R24	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A6R25	0698-6943		RESISTOR 20K .1% .125W F TC=0+-50	24546	NC55
A6R26	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A6R27	0683-5655	1	RESISTOR 5.6M 5% .25W FC TC=-900/+1100	01121	CB5655
A6R28	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A6R29	0698-3157	2	RESISTOR 19.6K 1% .125W F TC=0+-100	16299	C4-1/8-T0-1962-F
A6R30	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A6R31	0757-0465		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A6R32	0683-4735	5	RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A6R33	0698-3157		RESISTOR 19.6K 1% .125W F TC=0+-100	16299	C4-1/8-T0-1962-F
A6R34	0683-1535		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A6R35	0757-0465		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A6R36	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A6R37	0683-4735		RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A6R38	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A6R39	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A6R40	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A6R41	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A6R42	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A6R43	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A6R44	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A6R45	0683-1245	1	RESISTOR 120K 5% .25W FC TC=-800/+900	01121	CB1245
A6R46	0683-4735		RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A6R47	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A6R48	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A6R49	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A6R50	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A6R51	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A6R52	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A6R53	0757-0290	1	RESISTOR 6.19k 1% .125W		
A6R54	0757-0349	1	RESISTOR 22.6k 1% .25W		
A6R55	0683-4735		RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A6R56	0683-4735		RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A6R57	0683-3325	2	RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A6R58	0757-1094	1	RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
A6R59	0698-3155		RESISTOR 4.64K 1% .125W F TC=0+-100	16299	C4-1/8-T0-4641-F
A6R60	0683-3325		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A6R61	0757-0465		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A6R62	0698-4433	1	RESISTOR 2.26K 1% .125W F TC=0+-100	16299	C4-1/8-T0-2261-F
A6R63	0757-0401	2	RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A6R64	0757-0401		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A6R65	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A6R66	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A6R67	2100-2522	2	RESISTOR-TRMR 10K 10% C SIDE-ADJ 1-TURN	30983	ET50X103
A6R68	2100-2522		RESISTOR-TRMR 10K 10% C SIDE-ADJ 1-TURN	30983	ET50X103
A6R69	0683-2265		RESISTOR 22M 5% .25W		

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Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A6U1	1820-0630	1	IC MC 4044P DIGITAL	04713	MC4044P
A6U2	1826-0180	1	TIMER, NE555V	28480	1826-0180
A6U3	1820-0099	1	IC:SN7493N	01295	SN7493N
A6U4	1820-0054	2	IC SN74 00 N GATE	01295	SN7400N
A6U5	1820-0075	1	IC SN74 73 N FLIP-FLOP	01295	SN7473N
A6U6	1820-0379	1	IC:TTL 4-W AND/OR GATE	01295	SN74H52N
A6U7	1820-0054		IC SN74 00 N GATE	01295	SN7400N
A6U8	1826-0139		IC MC 1458 CP AMP	04713	MC1458P1
A6U9	1826-0139		IC MC 1458 CP AMP	04713	MC1458P1
A6U10	1826-0139		IC MC 1458 CP AMP	04713	MC1458P1
A6U11	1826-0271	5	IC UA 741C CP AMP	27014	LM741CN
A6U12	1826-0271		IC UA 741C CP AMP	27014	LM741CN
A6U13	1820-0321		IC UA 710C COMPARATOR	07263	710HC
A7	04261-77007	1	CLOCK PULSE GENERATOR/COUNTER BOARD ASSY	28480	04261-77007
A7C1	0160-2261	1	CAPACITOR-FXD 15PF +-5% 500WVDC CER	28480	0160-2261
A7C2	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A7C3	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A7C4	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A7C5	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A7C6	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X902082
A7R1	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A7R2	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A7R3	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A7R4	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A7R5	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A7R6	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A7U1	1820-0567	1	IC MC 4024P MV	04713	MC4024P
A7U2	1820-1490	4	IC SN74LS 90 N COUNTER	01295	SN74LS90N
A7U3	1820-1490		IC SN74LS 90 N COUNTER	01295	SN74LS90N
A7U4	1820-1490		IC SN74LS 90 N COUNTER	01295	SN74LS90N
A7U5	1820-1112	5	IC SN74LS 74 N FLIP-FLOP	01295	SN74LS74N
A7U6	1820-1490		IC SN74LS 90 N COUNTER	01295	SN74LS90N
A7U7	1820-1478	2	IC SN74LS 93 N COUNTER	01295	SN74LS93N
A7U8	1820-1478		IC SN74LS 93 N COUNTER	01295	SN74LS93N
A7U9	1820-1197		IC SN74LS 00 N GATE	01295	SN74LS00N
A7U10	1820-1217	7	IC SN74LS151 N MUXR	01295	SN74LS151N
A7U11	1820-1244	2	IC SN74LS153 N DATA SEL	01295	SN74LS153N
A7U12	1820-1244		IC SN74LS153 N DATA SEL	01295	SN74LS153N
A7U13	1820-1217		IC SN74LS151 N MUXR	01295	SN74LS151N
A7U14	1820-1112		IC SN74LS 74 N FLIP-FLOP	01295	SN74LS74N
A7U15	1820-1197		IC SN74LS 00 N GATE	01295	SN74LS00N
A7U16	1820-1112		IC SN74LS 74 N FLIP-FLOP	01295	SN74LS74N
A7U17	1820-1197		IC SN74LS 00 N GATE	01295	SN74LS00N
A7U18	1820-1217		IC SN74LS151 N MUXR	01295	SN74LS151N
A7U19	1820-1217		IC SN74LS151 N MUXR	01295	SN74LS151N
A7U20	1820-1204	1	IC SN74LS 20 N GATE	01295	SN74LS20N
A7U21	1820-1440	1	IC SN74LS279 N LATCH	01295	SN74LS279N
A7W1	8150-3490		JUMPER WIRE 3cm		
A7Y1	0410-0209	1	CRYSTAL-QUARTZ: 2.5465MHz	28480	0410-0209
A8	04261-77108	1	SEQUENTIAL CONTROL BOARD ASSEMBLY	28480	04261-77108
A8C1	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A8C2	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A8C3	0180-0291	1	CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A8C4	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X902082
A8C5	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A8C6	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X902082
A8CR1	1910-0016		DIODE-GE 60V 60NA 1US DO-7	28480	1910-0016
A8CR2	1910-0016		DIODE-GE 60V 60NA 1US DO-7	28480	1910-0016
A8CR5	1901-0025	1	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A8J1	1200-0853		SOCKET-IC 16-CONT DIP-SLDR-TERMS		
A8Q1	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A8Q2	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071

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Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A8R1	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A8R2	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A8R3	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A8R4	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A8R5	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A8R6	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A8R7	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A8R8	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A8R9	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A8R10	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A8R11	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A8R12	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A8R13	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+900	01121	CB1045
A8R14	0683-3315	1	RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A8R15	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A8R16	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A8R17	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A8R18	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A8R19	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A8R20	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A8R21	0683-4725		RESISTOR 4.7k 5% .25W FC TC=-400/+700	01121	CB4725
A8R22	0683-4725		RESISTOR 4.7k 5% .25W FC TC=-400/+700	01121	CB4725
A8R23	0683-4725		RESISTOR 4.7k 5% .25W FC TC=-400/+700	01121	CB4725
A8R24	0683-4725		RESISTOR 4.7k 5% .25W FC TC=-400/+700	01121	CB4725
A8R25	0683-4725		RESISTOR 4.7k 5% .25W FC TC=-400/+700	01121	CB4725
A8R26	0698-4431		RESISTOR 2.05k 1%		
A8R27	0757-0442		RESISTOR 10k 1% .125W		
A8S1	3101-1313		SWITCH-SL SPDT-NS SUBMIN 2A 120VAC PC		
A8U1	1820-1217		IC SN74LS151 N MUXR	01295	SN74LS151N
A8U2	1820-1493	2	IC MM74C163N COUNTER	27014	MM74C163N
A8U3	1820-1199		IC SN74LS 04 N INV	01295	SN74LS04N
A8U4	1820-1202	4	IC SN74LS 10 N GATE	01295	SN74LS10N
A8U5	1820-1358	2	IC LATCH	07263	93L34PC
A8U6	1820-1217		IC SN74LS151 N MUXR	01295	SN74LS151N
A8U7	1820-1493		IC MM74C163N COUNTER	27014	MM74C163N
A8U8	1818-2272	1	IC, R.O.M.	28480	1818-2272
A8U10	1820-1358		IC LATCH	07263	93L34PC
A8U11	1820-0471		IC SN74 06 N INV	01295	SN7406N
A8U12	1820-1217		IC SN74LS151 N MUXR	01295	SN74LS151N
A8U13	1820-1112		IC SN74LS 74 N FLIP-FLOP	01295	SN74LS74N
A8U14	1820-1197		IC SN74LS 00 N GATE	01295	SN74LS00N
A8U15	1820-1470	3	IC SN74LS157 N DATA SEL	01295	SN74LS157N
A8U16	1820-1194	1	IC SN74LS193N COUNTER	01295	SN74LS193N
A8U17	1820-1245	1	IC SN74LS155 N DECODER	01295	SN74LS155N
A8U18	1820-1469	1	IC SN74LS107 N FLIP-FLOP	01295	SN74LS107N
A8U19	1820-1197		IC SN74LS 00 N GATE	01295	SN74LS00N
A9	04261-77009	1	POWER SUPPLY BOARD ASSEMBLY	28480	04261-77009
A9C1	0180-1057	3	CAPACITOR:FXD 2200 UF 16VDCW AL ELECT	28480	0180-1057
A9C2	0180-1057		CAPACITOR:FXD 2200 UF 16VDCW AL ELECT	28480	0180-1057
A9C3	0180-1057		CAPACITOR:FXD 2200 UF 16VDCW AL ELECT	28480	0180-1057
A9C4	0180-1056		CAPACITOR:FXD 1000 UF 25VDC AL ELECT	28480	0180-1056
A9C5	0180-1056		CAPACITOR:FXD 1000 UF 25VDC AL ELECT	28480	0180-1056
A9C6	0140-0200	1	CAPACITOR-FXD 390PF +-5% 300WVDC MICA	72136	DM15E391J0300WV1C
A9C7	0180-0814	3	CAPACITOR:FXD 100UF +100-10% 16VDCW AL	28480	0180-0814
A9C8	0180-0814		CAPACITOR:FXD 100UF +100-10% 16VDCW AL	28480	0180-0814
A9C9	0180-0814		CAPACITOR:FXD 100UF +100-10% 16VDCW AL	28480	0180-0814
A9CR1	1901-0237	2	DIODE:SI, RECTIFIER BRIDGE, 200V	28480	1901-0237
A9CR2	1901-0237		DIODE:SI, RECTIFIER BRIDGE, 200V	28480	1901-0237
A9Q1	1854-0039	1	TRANSISTOR NPN 2N3053 SI TO-5 PD=1W	04713	2N3053
A9Q2	5080-3078		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A9Q3	5080-3078		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A9Q4	5080-3078		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A9R1	0811-2771	1	RESISTOR .18 5% 3W PW TC=0+-90		
A9R2	0811-1746	2	RESISTOR .36 5% 2W PW TC=0+-800	75042	BWH2-36/100-J
A9R3	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A9R4	0811-1746		RESISTOR .36 5% 2W PW TC=0+-800	75042	BWH2-36/100-J
A9R5	0757-0438	1	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-TO-5111-F
A9R6	2100-2521	1	RESISTOR-TRMR 2K 10% C SIDE-ADJ 1-TURN	30983	ET50X202
A9R7	0757-0440		RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-TO-7501-F
A9R8	0757-0289	1	RESISTOR 13.3K 1% .125W F TC=0+-100	19701	MF4C1/8-TO-1332-F
A9R9	0698-4020	1	RESISTOR 9.53K 1% .125W F TC=0+-100	16299	C4-1/8-TO-9531-F
A9R10	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1002-F

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Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A9R11	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1002-F
A9R12	0698-3155		RESISTOR 4.64K 1% .125W F TC=0+-100	16299	C4-1/8-TO-4641-F
A9R13	0698-3155		RESISTOR 4.64K 1% .125W F TC=0+-100	16299	C4-1/8-TO-4641-F
A9R14	0698-3431	1	RESISTOR 23.7 1% .125W F TC=0+-100	03888	PME55-1/8-TO-23R7-F
A9R15	0757-0420	1	RESISTOR 750 1% .125W F TC=0+-100	24546	C4-1/8-TO-751-F
A9R16	0698-3427	1	RESISTOR 13.3 1% .125W F TC=0+-100	03888	PME55-1/8-TO-13R3-F
A9R17	0757-0317		RESISTOR 1.33K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1331-F
A9R18	0757-0159		RESISTOR 1K 1% .5W		
A9R19	0683-7525		RESISTOR 7.5K 5% .25W		
A9U1	1826-0271		IC UA 741C OP AMP	27014	LM741CN
A9U2	5080-3834	1	IC UA 723C V RGLTR	07263	723HC
A9U3	1826-0271		IC UA 741C OP AMP	27014	LM741CN
A9U4	1826-0271		IC UA 741C OP AMP	27014	LM741CN
A10	04261-77010	1	MOTHER BOARD ASSEMBLY	28480	04261-77010
	04261-87010	1	BOARD:BLANK	28480	04261-87010
A10J1	1200-0853	7	SOCKET-IC 16-CONT DIP-SLOR-TERMS		
A10R1	1810-0164		NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0164
A10R2	1810-0164		NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0164
A10U1	1820-1470		IC SN74LS157 N DATA SEL	01295	SN74LS157N
A10U2	1820-1470		IC SN74LS157 N DATA SEL	01295	SN74LS157N
			A10 MISCELLANEOUS		
	0360-1653	4	TERMINAL-STUD SGL-PIN PRESS-MTG	28480	0360-1653
	1251-2035	15	CONNECTOR-PC EDGE 15-ONT/ROM 2-ROWS	71785	252-15-30-300
			CABLE ASSEMBLIES		
	04261-72003	1	CABLE ASSEMBLY (LCUR-A10)	28480	04261-72003
	04261-72004	1	CABLE ASSEMBLY (LPOTEN-A10)	28480	04261-72004
	04261-72005	1	CABLE ASSEMBLY (HCUR-A10)	28480	04261-72005
	04261-72006	1	CABLE ASSEMBLY (HPOTEN-A10)	28480	04261-72006
	04261-72007	1	CABLE ASSEMBLY (COFFSET-A10)	28480	04261-72007
	04261-82008	1	CABLE ASSEMBLY (LINE MODULE-POWER SWITCH)	28480	04261-82008
	04261-72023	1	CABLE ASSEMBLY (OPTION 003)	28480	04261-72023
A11 thru A20			NOT ASSIGNED		
A21	04261-77021	1	PARALLEL DATA OUTPUT BOARD ASSEMBLY (OPTION 001)	28480	04261-77021
A21C1	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A21C2	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A21C3	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A21C4	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A21CR1	1902-0041		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=-.009%	04713	SZ 10939-98
A21CR2	1902-0041		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=-.009%	04713	SZ 10939-98
A21J1	0360-1706	3	RIBBON CABLE 50-TERM INSUL DSPL TYPE	76381	3426-0000
A21J2	0360-1706		RIBBON CABLE 50-TERM INSUL DSPL TYPE	76381	3426-0000
A21R1	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A21R2	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A21R3	0683-1825		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A21R4	0683-1825		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A21R5	0683-1825		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825

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Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A21R6	0683-1825		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A21R7	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A21R8	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A21R9	0683-2725	6	RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A21R10	0683-2725		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A21R11	0683-2725		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A21R12	0683-2725		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A21R13	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A21R14	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A21R15	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A21R16	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A21R17	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A21R18	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A21U1	1820-0305	1	IC:TTL 4-BIT BINARY FULL ADDER	01295	SN7483N
A21U2	1820-0668	2	IC SN74 07 N BUFFER	01295	SN7407N
A21U3	1820-0282	2	IC SN74 86 N GATE	01295	SN7486N
A21U4	1820-0174	2	IC SN74 04 N INV	01295	SN7404N
A21U5	1820-1197		IC SN74LS 00 N GATE	01295	SN74LS00N
A21U6	1820-1199		IC SN74LS 04 N INV	01295	SN74LS04N
A21U7	1820-1202		IC SN74LS 10 N GATE	01295	SN74LS10N
A21U8	1820-0294	8	IC DM 85		
A21U9	1820-0294		IC DM 85		
A21U10	1820-0294		IC DM 85		
A21U11	1820-0294		IC DM 85		
A21W1	04261-72009	3	CABLE ASSEMBLY	28480	04261-72009
A21W2	04261-72009		CABLE ASSEMBLY	28480	04261-72009
A22	04261-77022	1	PARAMETER SERIAL PARALLEL BCD DATA OUTPUT BOARD ASSEMBLY (CPTION 002)	28480	04261-77022
A22C1	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A22C2	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A22C3	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A22C4	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A22C5	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A22C6	0160-2055		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0160-2055
A22CR1	1902-0041		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=-.009%	04713	SZ 10939-98
A22J1	0360-1706		RIBBON CABLE 50-TERM INSUL DSPL TYPE	76381	3426-0000
A22R1	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A22R2	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A22R3	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A22R4	0683-1825		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A22R5	0683-1825		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A22R6	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A22R7	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A22R8	0683-2725		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A22R9	0683-2725		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A22R10	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A22R11	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A22R12	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A22R13	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A22R14	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A22R15	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A22R16	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A22R17	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A22R18	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A22R19	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A22R20	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A22R21	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A22S1	3101-1313	1	SWITCH-SL DP3T-NS MINTR .5A 125VAC/DC PC	79727	G128S-0004
A22U1	1820-0910	1	IC SN74LS 83 N ADDER	01295	SN74LS83N
A22U2	1820-0511	1	IC SN74 08 N GATE	01295	SN7408N
A22U3	1820-0668		IC SN74 07 N BUFFER	01295	SN7407N
A22U4	1820-0282		IC SN74 86 N GATE	01295	SN7486N
A22U5	1820-0174		IC SN74 04 N INV	01295	SN7404N
A22U6	1820-1197		IC SN74LS 00 N GATE	01295	SN74LS00N
A22U7	1820-1199		IC SN74LS 04 N INV	01295	SN74LS04N
A22U8	1820-1202		IC SN74LS 10 N GATE	01295	SN74LS10N
A22U9	1820-0762	4	IC SN74 157 N MUXR	01295	SN74157N
A22U10	1820-0762		IC SN74 157 N MUXR	01295	SN74157N

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Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A22U11	1820-0762		IC SN74 157 N MUXR	01295	SN74157N
A22U12	1820-0762		IC SN74 157 N MUXR	01295	SN74157N
A22U13	1820-1433		IC SN74LS164 N RGTR	01295	SN74LS164N
A22U14	1820-1433		IC SN74LS164 N RGTR	01295	SN74LS164N
A22U15	1820-1433		IC SN74LS164 N RGTR	01295	SN74LS164N
A22U16	1820-1433		IC SN74LS164 N RGTR	01295	SN74LS164N
A22U17	1820-1112		IC SN74LS 74 N FLIP-FLOP	01295	SN74LS74N
A22U18	1820-1202		IC SN74LS 10 N GATE	01295	SN74LS10N
A22U19	1820-1212	1	IC SN74LS112 N FLIP-FLOP	01295	SN74LS112N
A22U20	1820-1144		IC SN74LS 02 N GATE	01295	SN74LS02N
A22W1	04261-72009		CABLE ASSEMBLY	28480	04261-72009
C1	0160-4259	4	CAPACITOR 0.22UF 10%	04713	SR2080-2
	2190-0205	4	WASHER (FOR TRANSISTOR RETAINING SCREWS)	04713	SR2080-2
	3050-0010	6	WASHER-FLAT	04713	1N3997R
C2	0160-1586		CAPACITOR-FXD MY 0.1UF 10% 100VDCW	28480	
C3	0160-1586		CAPACITOR-FXD MY 0.1UF 10% 100VDCW	28480	
CR4	1901-0033		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
CR5	1901-0033		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
CR6	1901-0033		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
CR7	1901-0033		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
F1	2110-0201	1	FUSE .25A 250V SLO-BLO 1.25X .25 UL IEC	75915	313.250S
	2110-0202	1	FUSE .5A 250V SLO-BLO 1.25X .25 UL IEC	75915	313.500S
R1	0683-1025		RESISTOR 1k 5% .25W FC TC=-400/+600	01121	CB1025
R2	0698-3391		RESISTOR 21.5 OHM 1% 1/2W		
R3	0698-3391		RESISTOR 21.5 OHM 1% 1/2W		
W1	8120-1378	1	CABLE ASSY 3-COND 18-AWG (POWER)	28480	8120-1378
	6960-0016	1	PLUG-HOLE TR-HD .125-DIA NYL (INST CARD STOPPER)	02768	207-080501-01-0101
	7120-0321	1	NAMEPLATE:CAUTION (JAPANESE)	28480	7120-0321
	2360-0117	6	SCREW-MACH 6-32 .375-IN-LG PAN-HD-POZI FOR RETAINING A10	28480	2360-0117
	2360-0201	2	SCREW MACH 6-32 .375-IN-LG PAN-HD-POZI FOR RETAINING A10	28480	2360-0201
	1251-0048	1	CONNECTOR-AC PWR 5-15 FEM ADPTR	80126	C-0602-000-BLACK
	2950-0072	1	NUT-HEX-DBL-CHAM 1/4-32-THD .062-THK (FOR MANUAL SWITCH)	82389	P-1975
J10, J11	5060-4020	2	CONNECTOR ASSEMBLY, 50-CONTACT (OPT. 001/002)	28480	5060-4020
	7120-3185	1	LABEL, INFO. CAUTION (ENGLISH)	28480	7120-3185
	5001-0439	2	TRIM SIDE	28480	5001-0439
	5040-7203	1	TRIM STRIP	28480	5040-7203
	0590-0025	2	NUT-HEX-PLSTCLKG 6-32-THD .172-THK (FOR XA9L)	72962	6SNA 97NM62
J12	04261-77123	1	CONNECTOR BOARD ASSEMBLY (OPTION 003)	28480	04261-77123
	04261-85021	1	FILM (1) ANNUNCIATOR	28480	04261-85021
	04261-40023	1	LAMP HOUSE (CIRCUIT MODE)		
	04261-40024	1	LAMP HOUSE (UNIT)		
	04261-85022	1	FILM (2) CKT MODE	28480	04261-85022
	04261-85023	1	NAMEPLATE (OPTION 002)	28480	04261-85023
	7120-5088	1	LABEL, INFO (POWER RATING)	28480	7120-5088
			OPTION 010		
A4	04261-66904		OSCILLATOR/RANGE RESISTOR BOARD ASSEMBLY		
A4R2	0698-4482		RESISTOR 17.4k OHM 1% .125W.		
A4R4	0698-3136		RESISTOR 17.8k OHM 1% .125W		
A4R5	0757-0470		RESISTOR 162k OHM 1% .125W		
A4R6	0757-0470		RESISTOR 162k OHM 1% .125W		
A6	04261-66906		PHASE DETECTOR/INTEGRATOR BOARD ASSEMBLY		
A6C10	0160-1563		CAPACITOR-FXD .47UF 5%		
A6CR5	1902-3083		DIODE-ZNR 4.64V 2%		

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Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
1	2360-0333	6	SCREW-MACH 6-32 100 DEG FL HD POZI REC	28480	2360-0333
2	5060-9964	1	COVER, BOTTOM	28480	5060-9964
3	04261-10024	1	DECK, LEFT	28480	04261-10024
4	2360-0115	22	SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	28480	2360-0115
5	04261-10026	1	HEAT SINK	28480	04261-10026
6	2510-0192	16	SCREW-MACH 8-32 100 DEG FL HD POZI REC	04866	YELLOW PATCH
7	5020-8816	1	FRAME, REAR	28480	5020-8816
8	5040-3318	1	COVER, L MODULE	28480	5040-3318
9	0960-0443	1	LINE MODULE	28480	0960-0443
10	04261-10001	1	PANEL, REAR	28480	04261-10001
11	2200-0141	4	SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	28480	2200-0141
12	04261-10030	4	TRANSISTOR COVER	28480	04261-10030
13(J1,J6)	1510-0107	2	BINDING POST-SGL 3/8-32 JGK/CBK SGL TU	28480	1510-0107
14(J2-J5,J7)	1510-0090	5	BINDING POST-SGL 3/8-32 JGK SGL TU	28480	1510-0090
15(J8,J9)	1250-0118	2	CONNECTOR-RF BNC FEM SGL HOLE FR	90949	31-2221-1022
16	2190-0016	10	WASHER-LK INTL T NO.-3/8 .377-IN-ID	78189	1920-02
17	2950-0043	5	NUT-HEX-DBL-CHAM 3/8-32-THD .094-THK	73743	2X 28200
18	2360-0113	15	SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	28480	2360-0113
19	5001-0460	1	COVER,TOP	28480	5001-0460
20	5040-7220	1	STRAP, HANDLE CAP, RIGHT	28480	5040-7220
21	2680-0172	2	SCREW-MACH 10-32 .375-IN-LG 100 DEG	28480	2680-0172
22	5060-9803	1	STRAP, HANDLE	28480	5060-9802
23	5040-7219	1	STRAP, HANDLE CAP, FRONT	28480	5040-7219
24	0590-0639	1	NUT	28480	0590-0639
25	04081-10027	4	SHIELD	28480	04081-10027
26	5020-8836	4	STRUT, CORNER	28480	5020-8836
27	04261-10025	1	DECK, RIGHT	28480	04261-10025
28	5020-8815	1	FRAME, FRONT	28480	5020-8815
29	04261-10022	1	SUB, PANEL FRONT	28480	04261-10022
30	04261-50121	1	PANEL, FRONT (YHP)	28480	04261-50121
30	04261-50122	1	PANEL, FRONT (HP)	28480	04261-50122
31	04261-10021	1	PANEL, FRONT	28480	04261-10021
32	04261-10031	1	PROTECTOR	28480	04261-10031
33	04261-99901	1	INSTRUCTION CARD (ENGLISH)	28480	04261-99901
33	04261-99900	1	INSTRUCTION CARD (JAPANESE)	28480	04261-99900
34	7120-0478	1	TRADE MARK (YHP)	28480	7120-0478
34	7120-1254	1	TRADE MARK (HP)	28480	7120-1254
35	5000-4206	3	SHORTING LINK	28480	5000-4206
36	0370-2159	1	KNOB:PUSHBUTTON	28480	0370-2159
37	2950-0001	4	NUT-HEX-DBL-CHAM 3/8-32-THD .094-THK	12697	20/4-13
38	1460-1345	2	WIREFORM 1.34-W 3-LG SST	28480	1460-1345
39	2200-0101	2	SCREW-MACH 4-40 .188 IN-LG PAN-HD-POZI	28480	2200-0101
40	5040-7201	4	FOOT, FULL/HALF MODULE	28480	5040-7201
41	04261-10028	1	SHIELD	28480	04261-10028
42	0360-1190	1	TERMINAL-LUG-SLDR 3/8 SCR .38/.078 ID	79963	720-.380H
43	04271-10030		PLATE	28480	04261-10030
44	0520-0129	6	SCREW-MACH 2-56 PAN-HD-POZI	28480	0520-0129
45	2190-0008	8	WASHER-LK EXT T NO.-6 .141-IN-ID	73734	1341
46	0624-0045	6	SCREW-TPG 6-20 .375-IN-LG PAN-HD PHL-REC	28480	0624-0045
47	0340-0458	1	INSULATOR-XSTR TO-3 .003-THK	28480	0340-0458
48(Q1)	1854-0063	1	TRANSISTOR NPN 2N3055 SI TO-3 PD=115W	28480	1854-0063
49(CR3)	1902-1232	1	DIODE-ZNR 1N3997AR 5.6V 5% DO-4 PD=10W	04713	1N3997R
50(CR1,CR2)	1901-0496	2	DIODE-PWR RECT 100V 12A DO-4	04713	SR2080-2
51	0360-0270	3	TERMINAL-LUG-SLDR 10 SCR .195/.093 ID	79963	807
52	3050-0226	4	WASHER-FL MTLC NO.-10 .203-IN-ID	80120	AN960C10L
53	1200-0080	4	INSULATOR-XSTR TRANSISTOR .19-ID	28480	1200-0080
54	2740-0003	3	NUT-HEX-W/LKWR 10-32-THD .125-THK	73734	9227
55	0340-0140	2	INSULATOR-XSTR TO-66 .003-THK	28480	0340-0140
56(Q2,Q3)	1854-0072	2	TRANSISTOR NPN 2N3054 SI TO-66 PD=25W	02735	2N3054
57	2510-0063	4	SCREW-MACH 8-32 1.5-IN-LG PAN-HD-POZI	28480	2510-0063
58	2190-0017	4	WASHER-LK HLCL NO.-8 .168-IN-ID	28480	2190-0017
59	3050-0130	4	WASHER-FL LAM 1.265-IN-ID 1.609-IN-OD	28480	3050-0130
60(T1)	9100-0850	1	TRANSFORMER:POWER	28480	9100-0850
30	04261-50124		PANEL FRONT (OPT. 010)		
33	04261-99902		INSTRUCTION CARD (OPT. 010)		

See introduction to this section for ordering information

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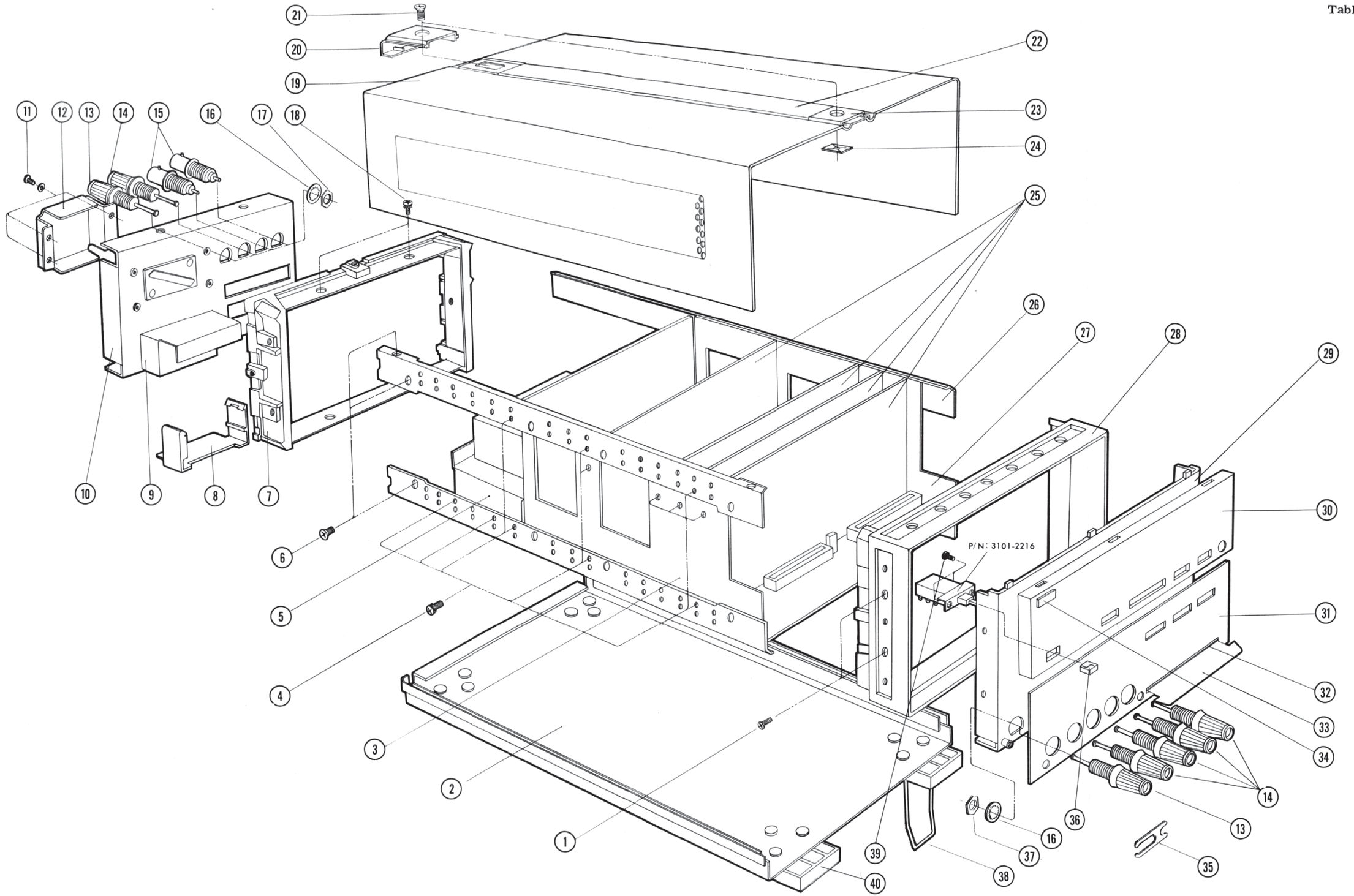

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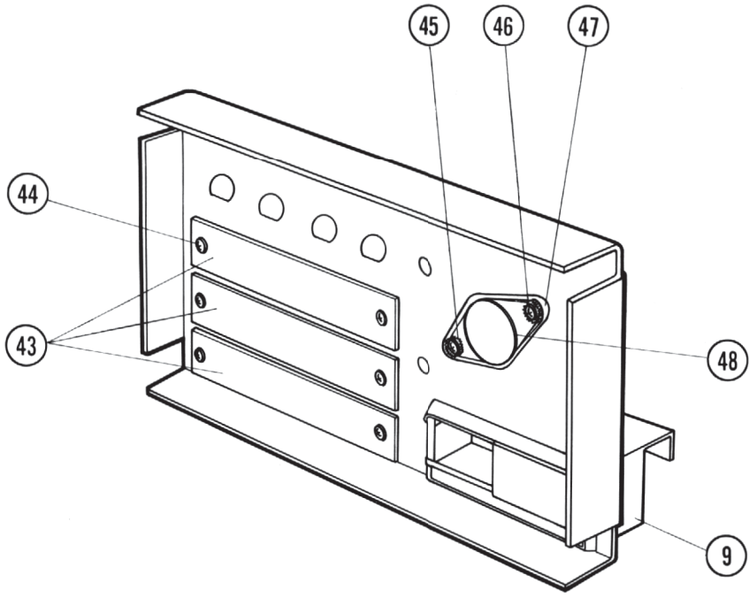

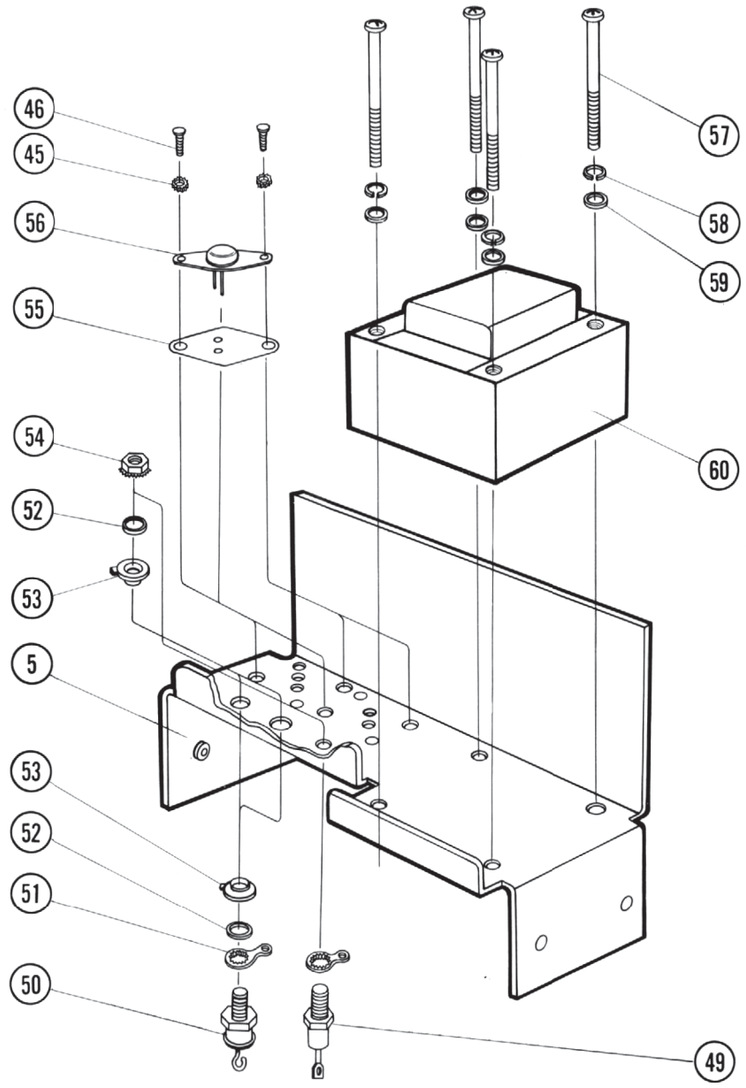

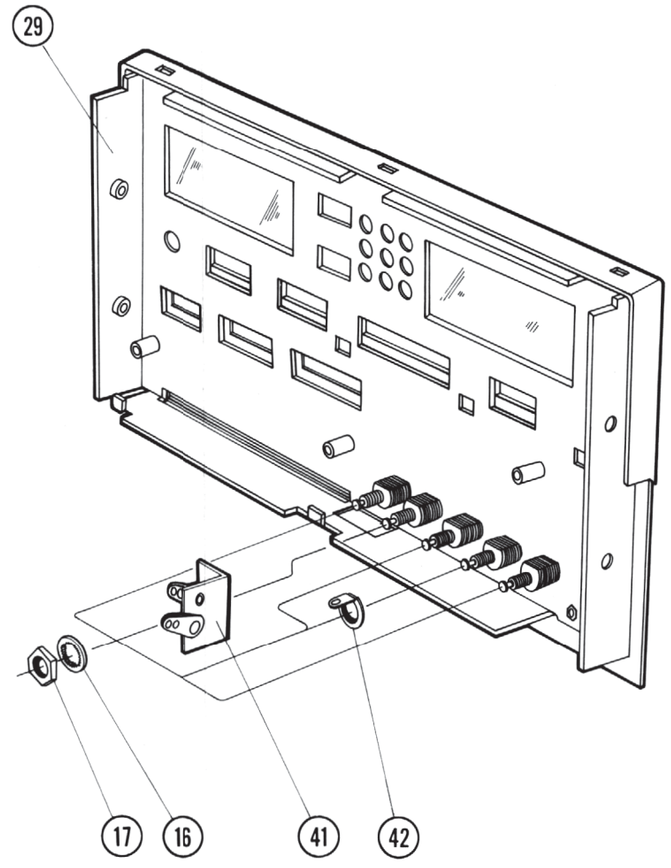

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SECTION VII
MANUAL CHANGES

7-1. INTRODUCTION.

7-2. This section contains information for adapting this manual to instruments to which the contents do not directly apply. The following paragraphs explain how to adapt this manual to apply to older instruments with lower serial prefixes.

7-3. MANUAL CHANGES.

7-4. To adapt this manual to your particular instrument, refer to Table 7-1 and make all of the manual changes listed opposite your instrument serial number. Perform these changes in the sequence listed. Table 7-2 gives a manual changes summary by assembly.

7-5. If your instrument serial number is not listed on the title page of this manual or in Table 7-1 to the right, it may be documented in a yellow MANUAL CHANGES supplement. For additional information about serial number coverage, refer to INSTRUMENT COVERED BY MANUAL in Section I.

Table 7-1. Manual Changes by Serial Number.

Serial Prefix or Number	Make Manual Changes
1545J-00320 and below	A, B, C, D, E, F, G
1545J-00400 and below	B, C, D, E, F, G
1622J00640 and below	C, D, E, F, G
1622J01290 and below	D, E, F, G
1810J and below	E, F, G
1821J04090 and below	F, G
1821J06370 and below	G

Table 7-2. Summary of Changes by Assembly.

CHANGE	Assembly												
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A21	A22	No Prefix
A		J1 thru J8		R53	C20								
B		04261-40025, 04261-40026, 04261-40027,	A3 C8 J4 R9 R10 U18 CR1 CR2 CR3 CR4 J5 U30 U31			C13 R53 R54		A8 C8 CR2 CR3 J2 R25 R26 R27 S1 U8 CR4 CR5 J3 J4 J5 S2 U9					04261-40023, 04261-40024,
C				R14 R26									
D													C2 R2 C3 R3

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Table 7-2. Summary of Changes by Assembly (Cont'd).

CHANGE	Assembly												
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A21	A22	No Prefix
E				CR4 CR7 CR10 CR11 CR23 CR24 K1 - K4 Q16 - Q19 R10 R13 R19 - R22 R40 - R47 R74 - R84									
F					U1 U3 CR1 CR2 R29 R30 R38 R39 R86								
G							S1						

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7-6. MANUAL CHANGE INSTRUCTIONS.

CHANGE A.

1. Page 8-61, Figure 8-26, A4 circuit schematics,
   Add the following note:

   A4R53 is constructed by two resistors in parallel, 11.111kΩ and 5.6MΩ. Since the resistance of these paralleled resistors is equal to 11.090kΩ, use A4R53 P/N: 0698-2295 for repair.

2. Page 8-63, Figure 8-29, A5 circuit schematics,
   Add the following note:

   In some instruments, A5C20 (39pF) is not installed in parallel with A5R31. Install A5C20 in all instruments (if not already included).

3. Page 6-3, Table 6-3, Replaceable Parts,
   Delete A2J1 thru J8, HP P/N: 1200-0474; jack.

   Note

   Above deletion does not apply to an instrument in which a a complete A2 board assembly has been used for repair.

CHANGE B.

1. Page 6-9, Table 6-3, Replaceable Parts,
   Add following parts:

   A6C13, HP P/N: 0160-1675; C-FXD .22μF.
   A6R53, HP P/N: 0757-0441; R-FXD 8.25kΩ.
   A6R54, HP P/N: 0757-0454; R-FXD 33.2kΩ.

   Delete following parts:

   A6C13, HP P/N: 0160-1674; C-FXD 0.33μF.
   A6R53, HP P/N: 0757-0290; R-FXD 6.19kΩ.
   A6R54, HP P/N: 0757-0349; R-FXD 22.6kΩ.

   Page 8-65, Figure 8-32, A6 circuit schematics,
   Change A6 circuit schematics partially per above changes.

2. Page 6-4, Table 6-3, Replaceable Parts,
   Delete following parts:

HP P/N: 04261-40025	1	SPACER FOR LED LAMP
HP P/N: 04261-40026	1	SPACER FOR LED LAMP
HP P/N: 04261-40027	1	SPACER FOR LED LAMP

   Page 6-15, Table 6-3, Replaceable Parts,
   Delete following parts:

HP P/N: 04261-40023	1	LAMP HOUSE
HP P/N: 04261-40024	1	LAMP HOUSE

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3. Page 6-4, Table 6-3, Replaceable Parts,
Add following parts:

A3, HP P/N: 04261-77003; A3 DISPLAY DRIVER BOARD
A3C8, HP P/N: 0160-2055; C-FXD .01μF
A3CR1, HP P/N: 1902-3002; DIODE-ZENER 2.37V
A3CR2, HP P/N: 1902-3002; DIODE-ZENER 2.37V
A3CR3, HP P/N: 1910-0016; DIODE GE SWITCHING
A3CR4, HP P/N: 1910-0016; DIODE GE SWITCHING
A3J4, HP P/N: 1200-0468; SOCKET
A3J5, HP P/N: 1200-0468; SOCKET
A3U30, HP P/N: 04261-85001; IC ROM
A3U31, HP P/N: 04261-85002; IC ROM

Delete following parts:

A3, HP P/N: 04261-77103; A3 DISPLAY DRIVER BOARD
A3C8, HP P/N: 0180-0374; C-FXD 10μF
A3J4, HP P/N: 1200-0613; SOCKET
A3R9, HP P/N: 0698-4431; R-FXD 2.05kΩ
A3R10, HP P/N: 0757-0442; R:FXD 10.0kΩ
A3U18, HP P/N: 1818-2271; IC-ROM

Pages 6-11 and 6-12, Table 6-3, Replaceable Parts,
Add following parts:

A8, HP P/N: 04261-77008; A8 SEQUENCE CONTROL BOARD
A8CR2, HP P/N: 1902-3002; DIODE-ZENER 2.37V
A8CR3, HP P/N: 1910-0016; DIODE-SWITCHING
A8CR4, HP P/N: 1902-3002; DIODE-ZENER 2.37V
A8CR5, HP P/N: 1901-0025; DIODE
A8J2, HP P/N: 1200-0468; SOCKET
A8J3, HP P/N: 1200-0468; SOCKET
A8J4, HP P/N: 1200-0438; SOCKET
A8J5, HP P/N: 1200-0438; SOCKET
A8S1, HP P/N: 3101-1274; SWITCH-SLIDE
A8S2, HP P/N: 3101-1274; SWITCH-SLIDE
A8U8, HP P/N: 04261-85003; IC-ROM
A8U9, HP P/N: 04261-85004; IC-ROM

Note

Delete following parts from above list for units serialized 1545J-00250 and below:

A8J4, HP P/N: 1200-0438; SOCKET
A8J5, HP P/N: 1200-0438; SOCKET

Delete following parts:

A8, HP P/N: 04261-77108; A8 SEQUENCE CONTROL BOARD
A8C8, HP P/N: 0180-0197; C-FXD 2.2μF
A8CR2, HP P/N: 1910-0016; DIODE SWITCHING
A8CR3, HP P/N: 1901-0025; DIODE
A8J2, HP P/N: 1200-0613; SOCKET
A8R25, HP P/N: 0683-4725; R-FXD 4.7kΩ 5%
A8R26, HP P/N: 0698-4431; R-FXD 2.05kΩ 1%
A8R27, HP P/N: 0757-0442; R-FXD 10.0kΩ
A8S1, HP P/N: 3101-1313; SWITCH-SLIDE
A8U8, HP P/N: 1818-2272; IC ROM

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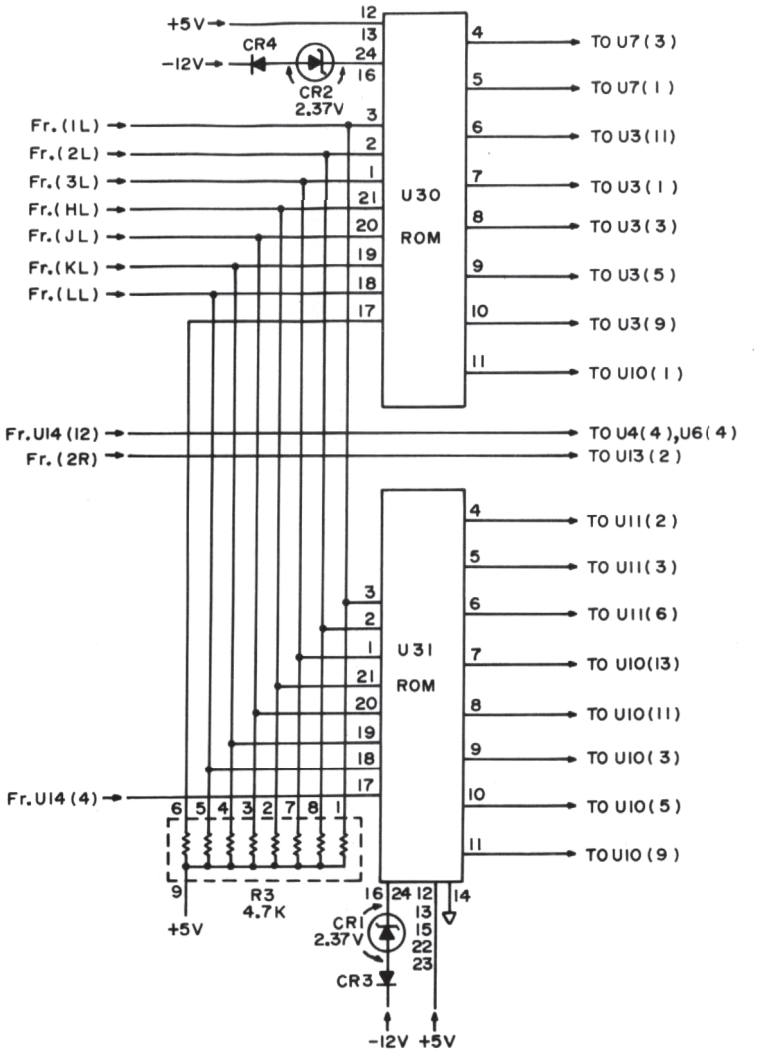
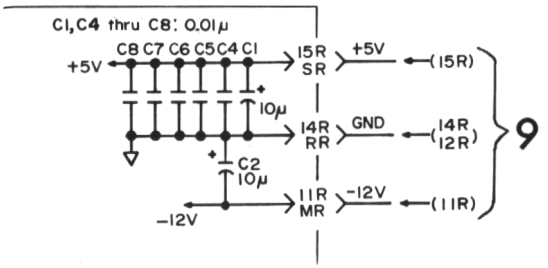
Page 8-59, Figure 8-23, A3 circuit schematics,
Change schematics partially as follows:





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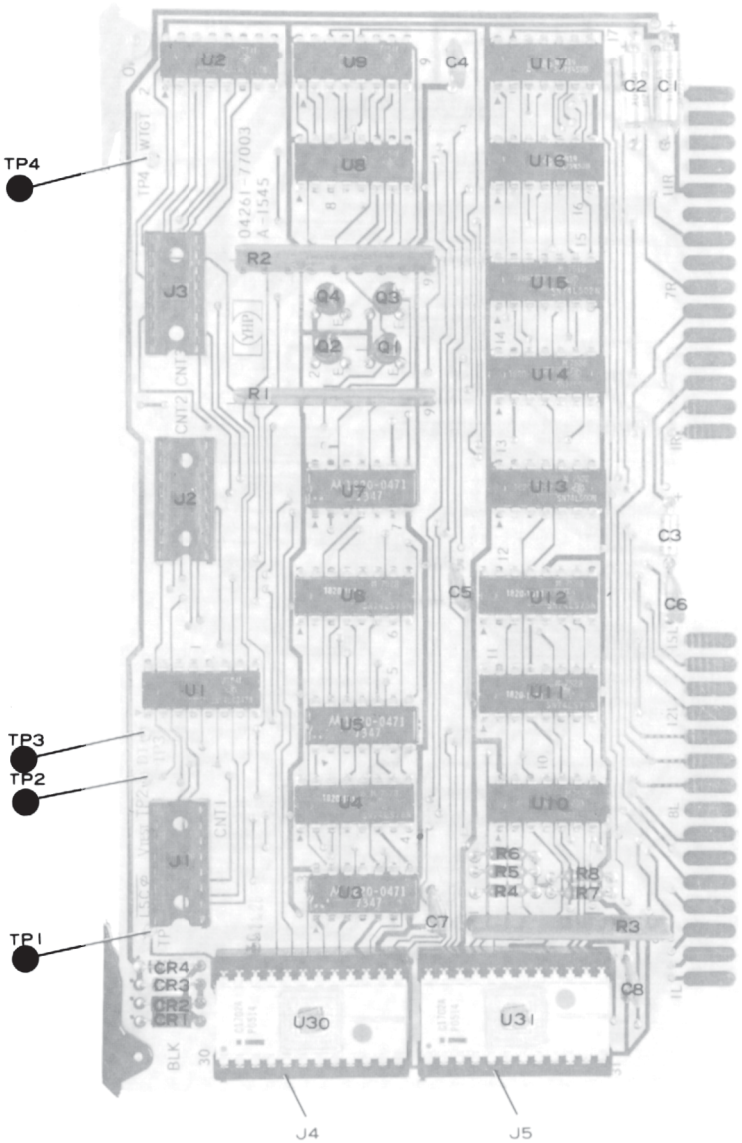
Page 8-59, Figure 8-22, A3 Parts Locations,
Change parts locations for A3 board as follows:



Replace A3U18 with A3U30, U31, and CR1 thru CR4 in the A3 board troubleshooting tree.

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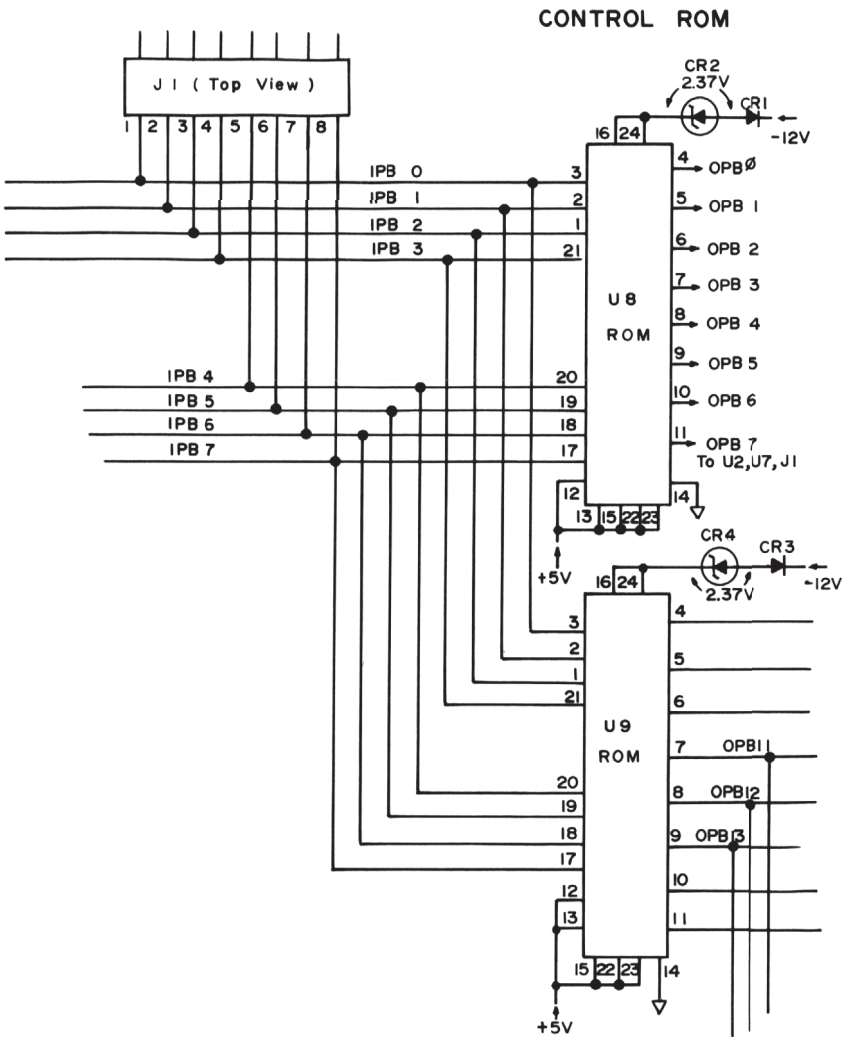
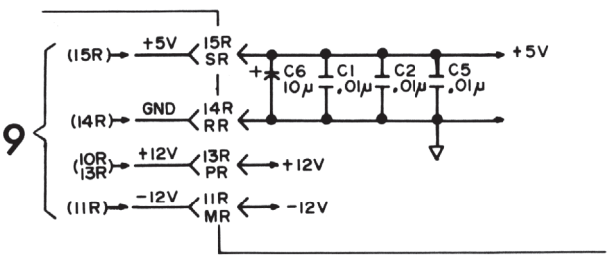
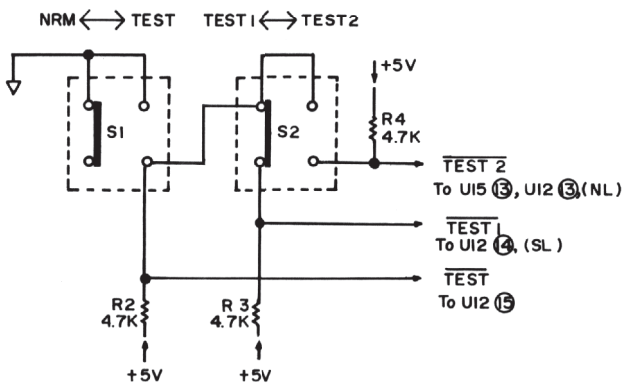
Page 8-69, Figure 8-36, A8 circuit schematics,
Change schematics partially as follows:







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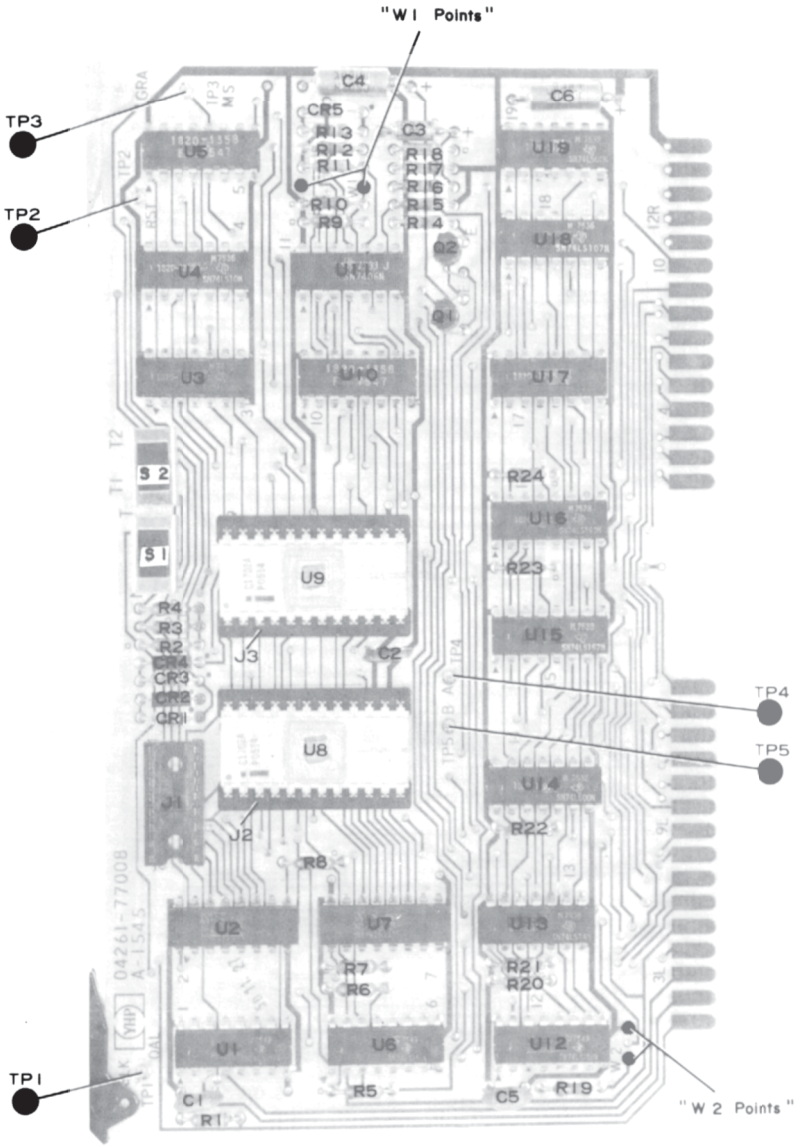
Page 8-69, Figure 8-35, A8 Parts Locations,
Change parts locations for A8 board as follows:



Note

J4 and J5 sockets are not installed in units serialized 1545J-00250 and below.

Replace A8U8 with A8U8, U9, and CR1 thru CR4 in troubleshooting guide Figure 8-12.

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CHANGE C.

1. Page 6-6, Table 6-3 and Page 8-61, Figure 8-26,
   Add following parts:

   A4R14, HP P/N: 0683-3335; R-FXD 33kΩ.
   A4R26, HP P/N: 0698-3259; R-FXD 7.87kΩ.

   Delete following parts:

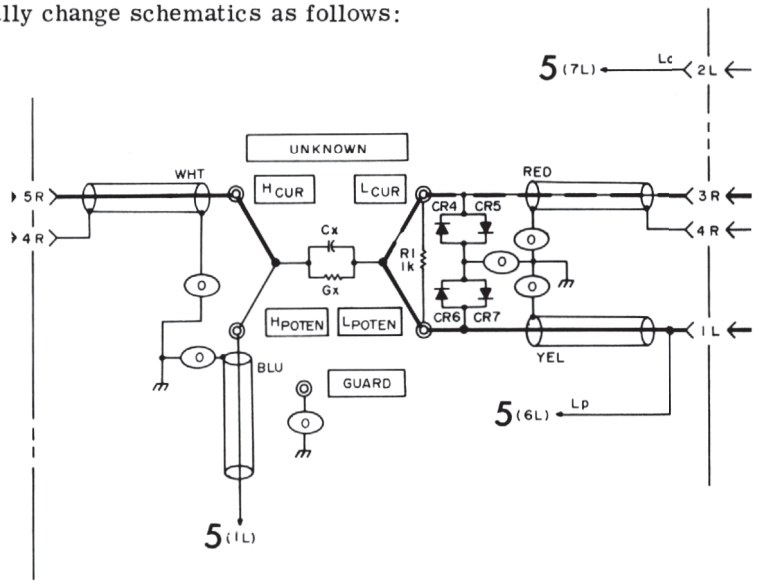
   A4R14, HP P/N: 0683-1035; R-FXD 10kΩ.
   A4R26, HP P/N: 0698-3515; R-FXD 5.90kΩ.

CHANGE D.

1. Page 6-15, Table 6-3, Replaceable Parts,
   Delete following parts:

   C2, HP P/N: 0160-1586; C-FXD 0.1μF.
   C3, HP P/N: 0160-1586; C-FXD 0.1μF.
   R2, HP P/N: 0698-3391; R-FXD 21.5Ω.
   R3, HP P/N: 0698-3391; R-FXD 21.5Ω.

2. Page 8-61, Figure 8-26, A4 Circuit Schematics,
   Partially change schematics as follows:



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CHANGE E.

1. Pages 6-5, 6-6 and 6-7, Table 6-3, Replaceable Parts, Change A4 board replaceable parts list to Table A.

Table A (Sheet 1 of 3).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
*A4C11	0160-2202	1	CAPACITOR-FXD 75pF +-5% 300WVDC MICA	28480	0160-2202
A4C12	0160-2307	1	CAPACITOR-FXD 47pF +-5% 300WVDC MICA	28480	0160-2307
A4C13	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4C14	0160-2264	1	CAPACITOR-FXD 20pF +-5% 500WVDC CER	28480	0160-2264
A4C15	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4C16	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4C17	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4C18	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4C19	0180-1051		CAPACITOR-FXD 100UF 16V	28480	0180-1051
A4CR1	1901-0040	42	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR2	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR3	1902-3036	1	DIODE-ZNR 3.16V 5% DO-7 PD=.4W TC=-.064%	04713	SZ 10939-38
A4CR4	1902-0025	1	DIODE-ZNR 10V 5% DO-7 PD=.4W TC=+.06%	04713	SZ 10939-182
A4CR5	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480 28480	1901-0040
A4CR6	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR7	1902-0654		DIODE-ZNR 33.2V 5% DO-15 PD-1W TC=+.075%	04713	SZ 11213-290
A4CR8	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR9	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR10	1902-0844	2	DIODE-ZNR 36V 5% DO-7 PD=.4W TC=+.057%	04713	SZ 10939-170
A4CR11	1902-0844		DIODE-ZNR 36V 5% DO-7 PD=.4W TC=+.057%	04713	SZ 10939-170
A4CR12	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR13	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR14	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR15	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR16	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR17	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR18	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR19	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR20	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR21	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR22	1902-3149	5	DIODE-ZNR 9.09V 5% DO-7 PD=.4W TC=+.057%	04713	SZ 10939-170
A4CR23	1901-0025	2	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A4CR24	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A4CR25	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR26	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR27	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR28	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4K1	0490-0234		RELAY:REED	28480	0490-0234
A4K2	0490-0226		RELAY:REED	28480	0490-0226
A4Q1	1855 0062	8	TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0062
A4Q2	1855-0091	21	TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
A4Q3	1855-0082	1	TRANSISTOR MOSFET P-CHAN D-MODE SI	28480	1855-0082
A4Q4	1854 0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q5	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q6	1853 0020	24	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A4Q7	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A4Q8	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q9	1853 0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A4Q10	1855-0118	2	TRANSISTOR J-FET N-CHAN 2SK43R	28480	1855-0118
A4Q11	1855 0118		TRANSISTOR J-FET N-CHAN 2SK43R	28480	1855 0118
A4Q12	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q13	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854 0071
A4Q14	1854 0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q15	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q16	1853 0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853 0020
A4Q17	1854-0474	2	TRANSISTOR NPN SI PD=360MW FT=75MHZ	28480	1854-0474
A4Q18	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853 0020
A4Q19	1854-0474		TRANSISTOR NPN SI PD=360MW FT=75MHZ	28480	1854-0474
A4Q20	1855-0091		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
A4Q21	1855 0091		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855 0091
A4Q22	1855-0091		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
A4Q23	1855-0091		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
A4Q24	1855 0091		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
A4Q25	1855-0091		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
A4Q26	1855 0117	1	TRANSISTOR J-FET N-CHAN E-108	28480	1855 0117
A4Q27	1855-0091		TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0091
A4Q28	1854-0013	1	TRANSISTOR NPN 2N2218A SI TO-5 PD=800MW	04713	2N2218A
A4Q29	1853-0012	1	TRANSISTOR PNP 2N2904A SI TO-5 PD=600MW	01295	2N2904A
A4Q30	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A4Q31	1853 0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A4Q32	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A4Q33	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A4Q34	1853 0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A4R1	0757-0486	2	RESISTOR 750K 1% .125W F TC=0+-100	24546	NA4
A4R2	0698 3136	1	RESISTOR 17.8K 1% .125W F TC=0+ 100	16299	C4-1/8-T0-1782 F
A4R3	0757-0486		RESISTOR 750K 1% .125W F TC=0+-100	24546	NA4
A4R4	0757-0448	1	RESISTOR 18.2K 1% .125W F TC=0+ 100	24546	C4-1/8-T0-1822 F
A4R5	0698-3451	2	RESISTOR 133K 1% .125W F TC=0+-100	16299	C4-1/8 T0-1333-F

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Table A (Sheet 2 of 3).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4R6	0698-3451		RESISTOR 133K 1% .125W F TC=0+-100	16299	C4-1/8-T0-1333-F
A4R7	0757-0317	2	RESISTOR 1.33K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1331-F
A4R8	0757-0278	1	RESISTOR 1.78K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1781-F
A4R9	0698-3155	4	RESISTOR 4.64K 1% .125W F TC=0+-100	16299	C4-1/8-T0-4641-F
A4R10	0683-3335	38	RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R11	0683-8225	1	RESISTOR 8.2K 5% .25W FC TC=-400/+700	01121	CB8225
A4R12	0698-3154	1	RESISTOR 4.22K 1% .125W F TC=0+-100	16299	C4-1/8-T0-4221-F
A4R13	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R14	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+800	01121	CB3335
A4R15	0757-0443	1	RESISTOR 11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1102-F
A4R16	0757-0416	3	RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A4R17	0698-4442	1	RESISTOR 4.42K 1% .125W F TC=0+-100	16299	C4-1/8-T0-4421-F
A4R18	0698-4420	1	RESISTOR 226 1% .125W F TC=0+-100	16299	C4-1/8-T0-226R-F
A4R19	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R20	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R21	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R22	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R23	0683-4725	43	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A4R24	0683-7525	1	RESISTOR 7.5K 5% .25W FC TC=-400/+700	01121	CB7525
A4R25	0757-0442	4	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A4R26	0698-3515	1	RESISTOR 5.90K 1% .125W F TC=0+-100	16299	C4-1/8-T0-5901-F
A4R27	0683-1535	3	RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A4R28	0683-1535		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A4R29	0683-0275	4	RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	CB27G5
A4R30	0683-0275		RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	CB27G5
A4R31	0764-0015	1	RESISTOR 560 5% 2W MO TC=0+-200	24546	FP42-2-T00-561-J
A4R32	0757-0465	4	RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A4R33	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A4R34	0683-1055	28	RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A4R35	0698-0083	2	RESISTOR 1.96K 1% .125W F TC=0+-100	16299	C4-1/8-T0-1961-F
A4R36	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A4R37	0698-3440	2	RESISTOR 196 1% .125W F TC=0+-100	16299	C4-1/8-T0-196R-F
A4R38	0698-3440		RESISTOR 196 1% .125W F TC=0+-100	16299	C4-1/8-T0-196R-F
A4R39	0683-0825	1	RESISTOR 8.2 5% .25W FC TC=-400/+500	01121	CB82G5
A4R40	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R41	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R42	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R43	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R44	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R45	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R46	0683-1045	6	RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A4R47	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R48	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R49	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A4R50	0683-5625	1	RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625
A4R51	0683-2225	2	RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A4R52	0698-2225	1	RESISTOR:FXD 90.0K OHM 0.05% 1/8W MF	28480	0698-2225
A4R53	0698-2295	1	RESISTOR:FXD 11.090 OHM 0.05%	28480	0698-2295
A4R54	0698-3329	1	RESISTOR 10K .5% .125W F TC=0+-100	03888	PME55-1/8-T0-1002-D
A4R55	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A4R56	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A4R57	0698-2296	1	RESISTOR:FXD 1010.1 OHM 0.05%	28480	0698-2296
A4R58	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A4R59	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A4R60	0698-2294	1	RESISTOR:FXD 100.10HM 0.05%	28480	0698-2294
A4R61	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A4R62	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A4R63	0698-2298	1	RESISTOR:FXD 10 OHM 0.05%	28480	0698-2298
A4R64	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A4R65	0683-1055		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A4R66	0683-4705	2	RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A4R67	0683-4705		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A4R68	0683-1035	11	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A4R69	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A4R70	0757-1090	2	RESISTOR 261 1% .5W F TC=0+-100	19701	MF7C1/2-T0-261R-F
A4R71	0683-0275		RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	CB27G5
A4R72	0683-0275		RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	CB27G5
A4R73	0757-1090		RESISTOR 261 1% .5W F TC=0+-100	19701	MF7C1/2-T0-261R-F
A4R74	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R75	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R76	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R77	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R78	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335

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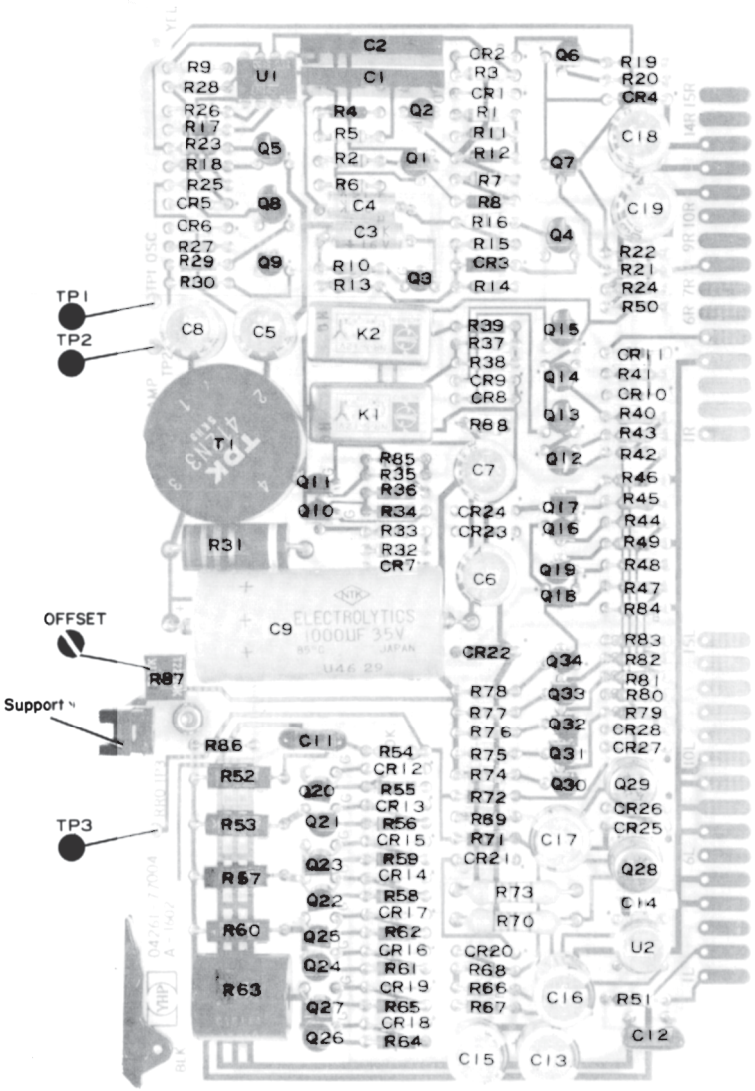
Table A (Sheet 3 of 3).

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4R79	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R80	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R81	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R82	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R83	0683-3335		RESISTOR 33k 5% .25W FC TC=-400/+800	01121	CB3335
A4R84	0683-3335		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A4R85	0698-0083		RESISTOR 1.96k 1% .125W F TC=0+-100	16299	C4-1/8-T0-1961-F
A4R86	0683-1065	1	RESISTOR 10M 5% .25W FC TC=-900/+1000	01121	CB1065
A4R87	2100-2514	1	RESISTOR-TRMR 20k 10% C SIDE-ADJ 1-TURN	30983	ET50W203
A4R88	0683-4705		RESISTOR 470HM		
A4T1	9100-0846	1	TRANSFORMER-PULSE 412N3	28480	9100-0846
A4U1	1826-0139	6	IC MC 1458 OP AMP	04713	MC1458P1
A4U2	1826-0013	1	IC OP AMP	28480	1826-0013
	04261-50022	1	SUPPORTER, BOARD	28480	04261-50022

2. Page 8-61, Figure 8-25, A4 board component locations,
Change A4 board component location illustration as follows:



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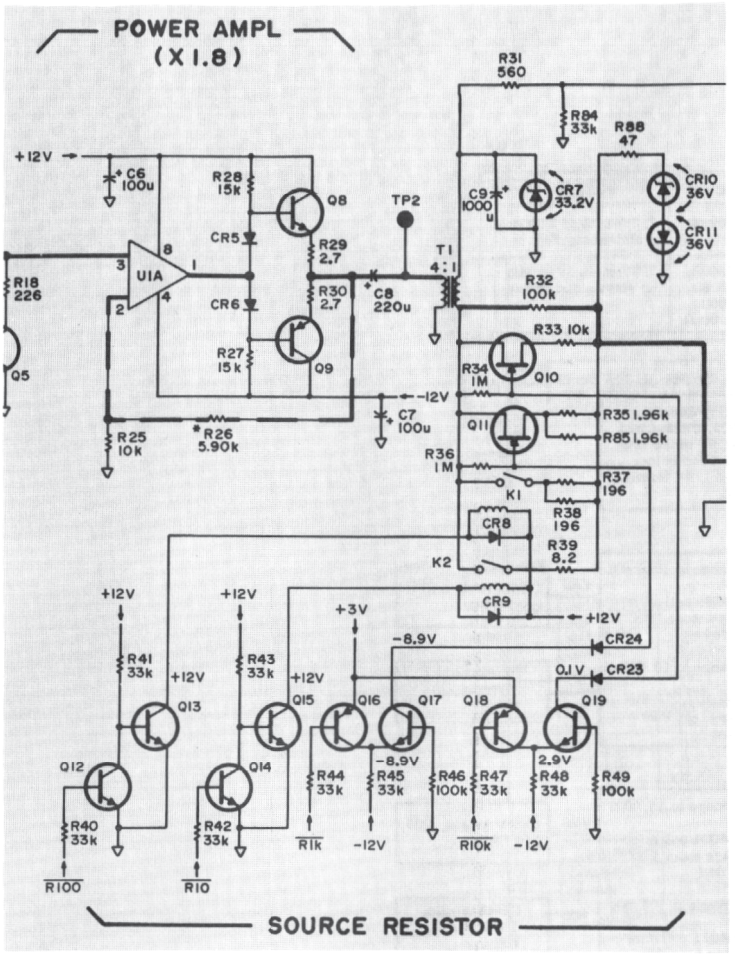
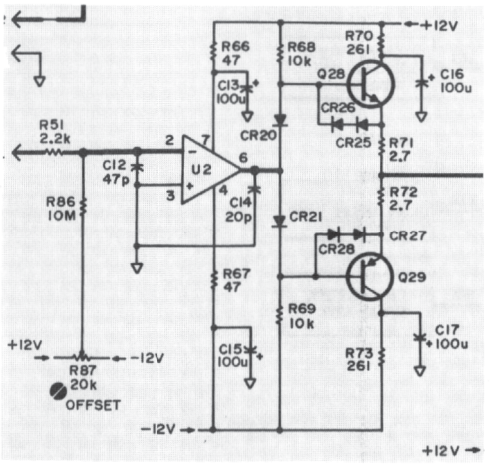
3. Page 8-61, Figure 8-26, A4 board schematic diagram,
Partially change A4 board schematic diagram as follows:





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4. Page 8-60, Figure 8-24, A4 board Troubleshooting Guide,
Change A4 board Troubleshooting Guide to Figure A.

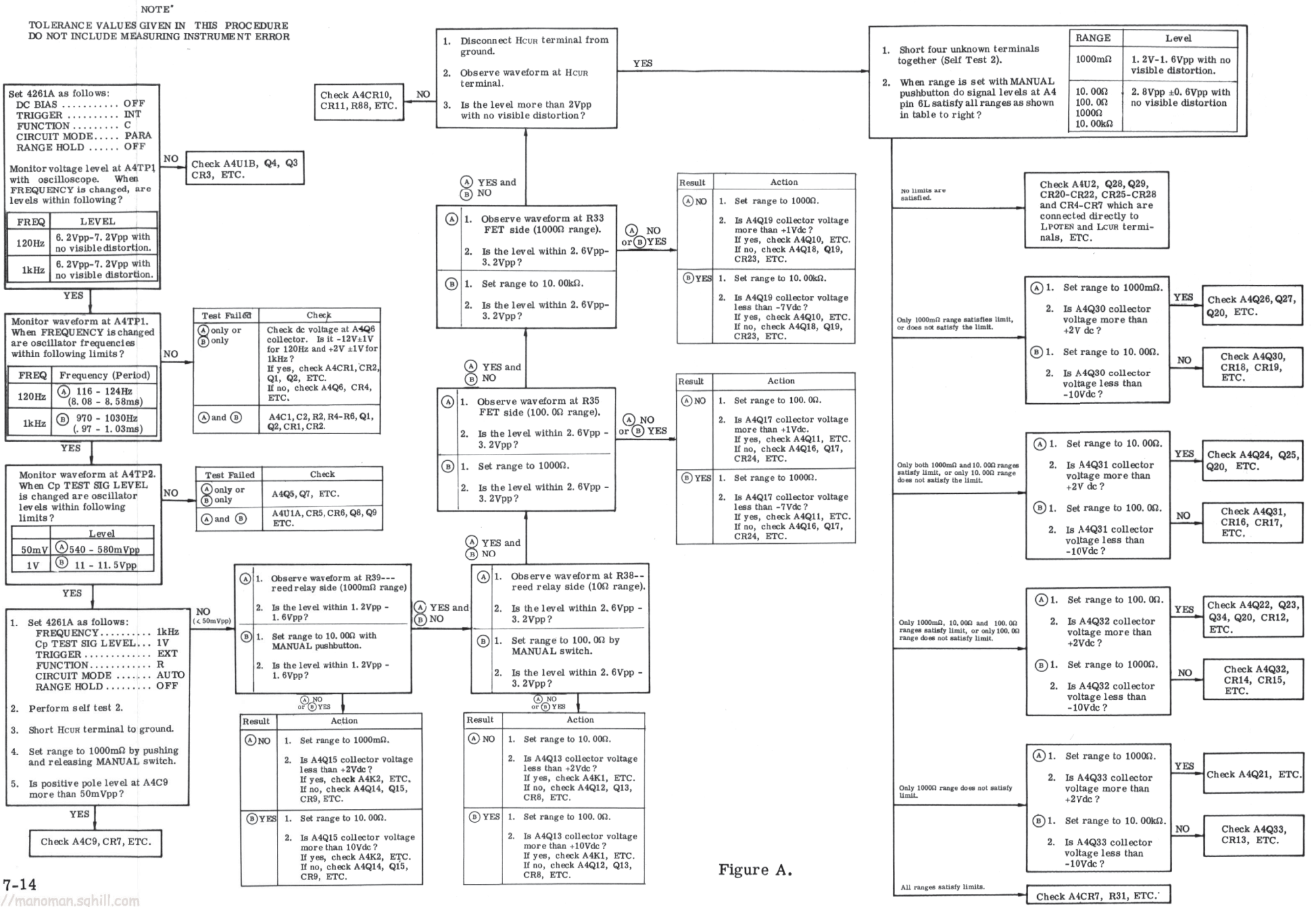

Figure A.

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CHANGE F.

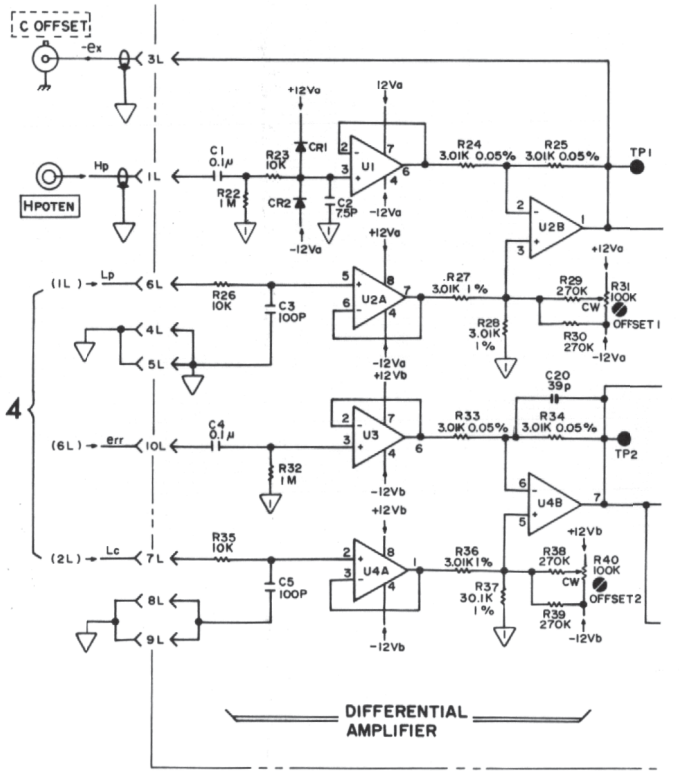
1. Pages 6-8 and 6-9, Table 6-3, Replaceable Parts,
Add following parts:

A5CR1, HP P/N: 1901-0033; DIODE-GEN PRP 180V 200MA
A5CR2, HP P/N: 1901-0033; DIODE-GEN PRP 180V 200MA
A5CR3, HP P/N: 1902-3149; DIODE-ZNR 9.09V 5% PD=.4W
A5R29, HP P/N: 0683-2745; R-FXD 270K 5% .25W
A5R30, HP P/N: 0683-2745; R-FXD 270K 5% .25W
A5R38, HP P/N: 0683-2745; R-FXD 270K 5% .25W
A5R39, HP P/N: 0683-2745; R-FXD 270K 5% .25W
A5U1, HP P/N: 1826-0043; IC LM 307 OP AMP
A5U3, HP P/N: 1826-0043; IC LM 307 OP AMP

Delete following parts:

A5CR1, HP P/N: 1901-0376; DIODE-GEN PRP
A5CR2, HP P/N: 1901-0376; DIODE-GEN PRP
A5R29, HP P/N: 0683-5645; R-FXD 560K 5% .25W
A5R38, HP P/N: 0683-5645; R-FXD 560K 5% .25W
A5R86, HP P/N: 0683-4725; R-FXD 4.7K 5% .25W
A5U1, HP P/N: 1826-0319; IC LF356H OP AMP
A5U3, HP P/N: 1826-0319; IC LF356H OP AMP

2. Page 8-63, Figure 8-29, A5 circuit schematics,
Change schematics partially as follows:



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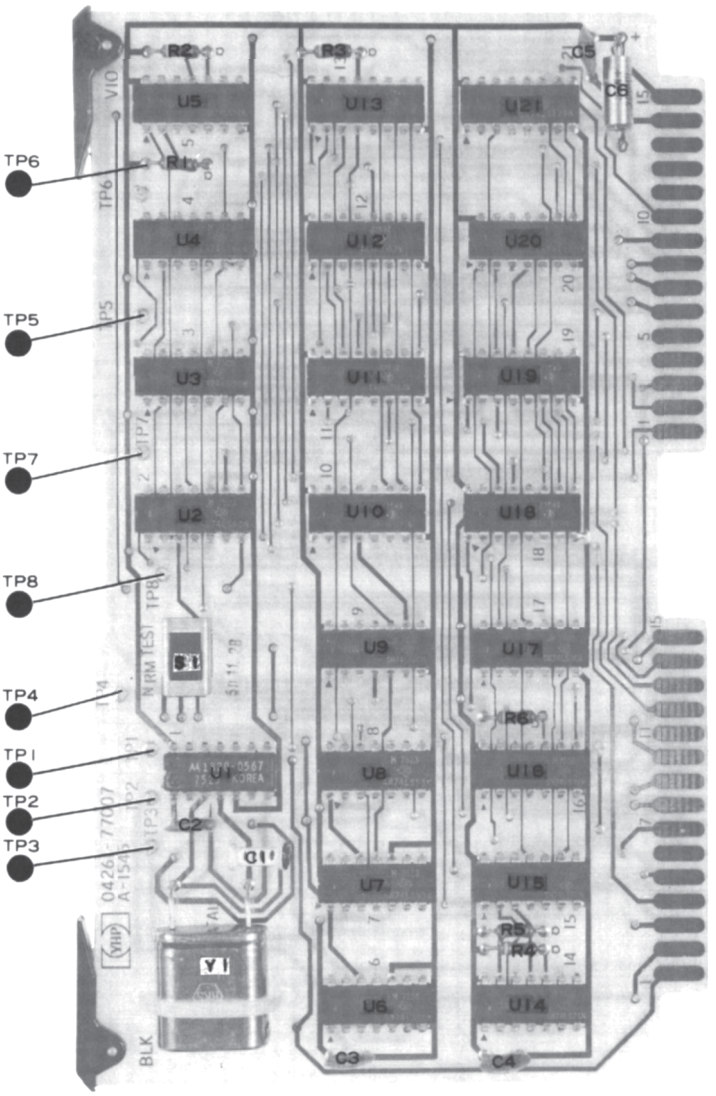
CHANGE G.

1. Page 8-67, Figure 8-33. A7 Board Assembly Component Locations:

Change parts locations for the A7 board as follows:



Note

A switch, A7C1, is installed in place of jumper A7W1 on units serial-numbered 1821J06370 and below.

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SECTION VIII
SERVICE

8-1. INTRODUCTION.

8-2. This section contains information on servicing the Model 4261A including the theory of operation, troubleshooting and repair. Overall theory of operation of the instrument is covered in the first part of this section and detailed explanations are presented in the service sheets including detailed theory, component level troubleshooting, circuit schematics and parts location. Interior views, which show adjustment locations, are also included in this section.

8-3. THEORY OF OPERATION.

8-4. A general explanation of the theory of operation of the 4261A LCR Meter follows. Since detailed circuit descriptions for each assembly are covered in the service sheets, the explanation that follows is limited to:

Basic Theory
Block Diagram Discussions
Timing Diagram Discussions

8-5. BASIC THEORY.

8-6. Figure 8-1 is the basic block diagram of the 4261A and shows the fundamentals of how the 4261A measures inductance L, capacitance C, resistance R and/or dissipation factor D. The output of an oscillator is applied through a source resistor Ro to the unknown device and range resistor Rr. The effect of amplifier Rr is to cause the same current that flows through the unknown device to flow through Rr, and, as a result, to drive the junction of the unknown device and Rr to zero volts. Voltages E1 and E2 across the unknown device and across Rr, respectively, are connected to selector switches S1 and S2 which have two important functions. First, S1 selects either E1 or E2 as the voltage to drive the four phase generator (this also establishes the measurement mode - either series or parallel which is automatically or manually set (PARA or SER) as selected at the front panel) and, secondly, S2 selects either E1 or E2 as the measurement voltage to charge or discharge the integrator (as appropriate to the measurement function and mode, i.e. Cp, Cs, Lp, Ls, Rp or Rs). The Vector Voltage-Ratio Measurement Section calculates an L, C, R or D measurement by ascertaining the voltage ratio of E1 and E2 through a dual-slope (type) analog to digital conversion technique. This technique is popularly used in digital voltmeters. The analog section receives its measurement instructions from a digital section.

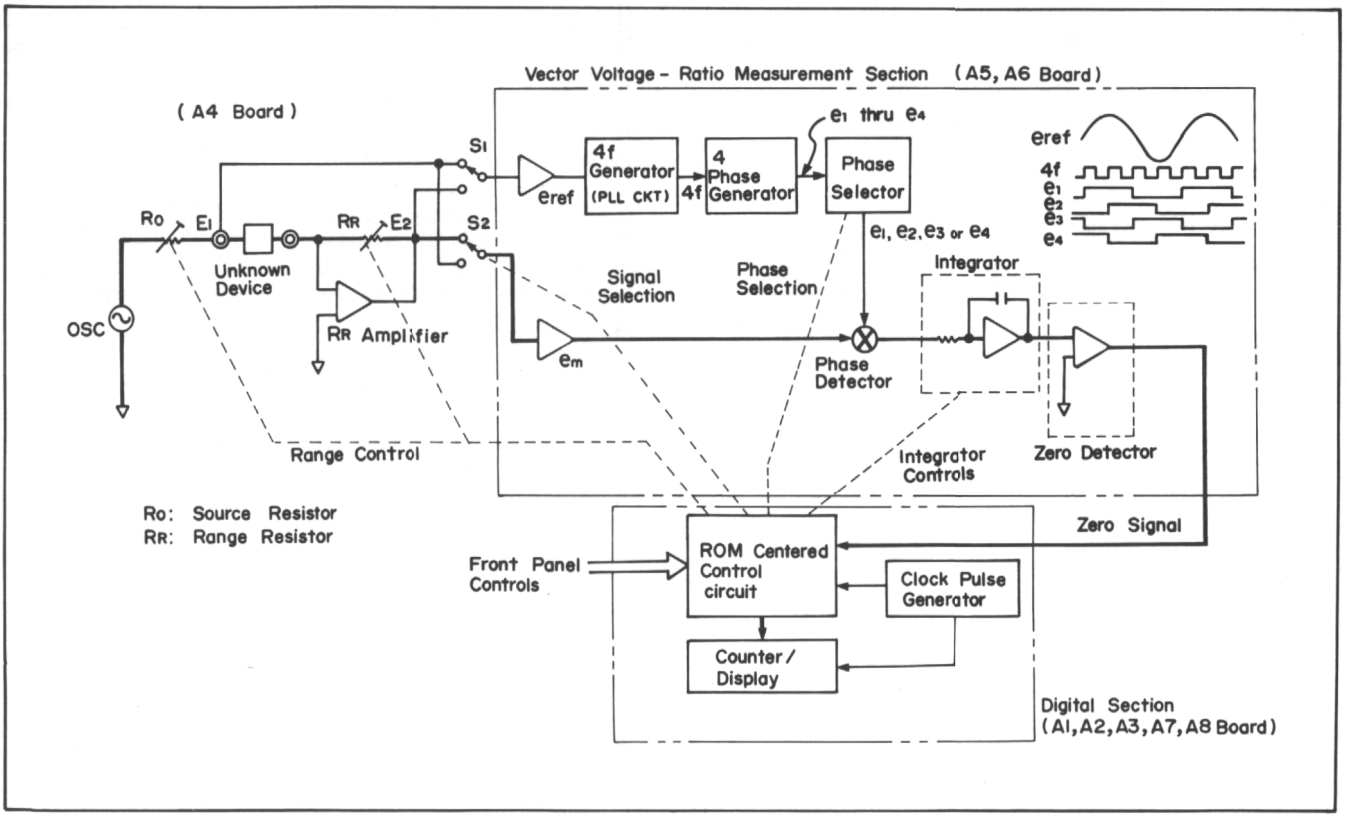

Figure 8-1. Basic Block Diagram.

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8-7. Source and range resistors, Ro and Rr, are automatically selected by digital control circuits. For a series equivalent circuit measurement (Ls, Cs or Rs), Ro is set to a value much greater than the impedance of unknown device. Thus a constant current drive to the unknown device is realized. On the other hand, for a parallel equivalent circuit measurement (Lp, Cp or Rp), Ro is set to a much smaller value than the impedance of the unknown to achieve a constant voltage drive to the unknown. The resistance values of Ro and Rr *are always* equal.

8-8. Vector Voltage-Ratio Measurement Section. The e_m signal selected by S2 (as directed by the logic circuit) is detected by a phase detector that outputs the rectangular component or in-phase component to an integrator. Phase detector signals e_1 thru e_4 supplied to the phase detector are produced in the following manner: A 4f signal is generated from an e_{ref} signal as selected by Switch S1 (the 4f generator is a phase lock loop circuit). This creates signals e_1 thru e_4, each being different by 90 degrees in phase from one another (a 4 phase generator). One of these signals, as directed by the digital circuitry, detects the e_m measurement signal. The phase of signals e_1 thru e_4 is very accurate as a PLL (phase lock loop) circuit is used for generating the reference phase signal to minimize measurement error. A zero detector takes the output of the integrator and generates a zero detection signal (ZERO) every time the integrator output crosses the zero level. This furnishes a ZERO signal to the Digital Section.

8-9. The Digital Section is a kind of algorithmic state machine that is driven by the state clock from a built-in clock pulse generator. The major functions of this section are to manage the various sequences required to perform the desired measurements, to measure L, C, R and D values converted into time periods, and to display these values at the 4261A front panel.

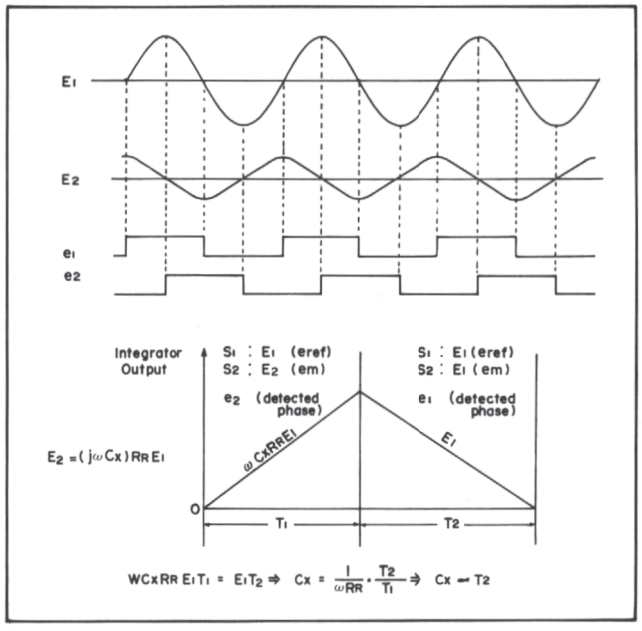

Figure 8-2. Cp Measurement Principle.

8-10. The parallel capacitance Cp measurement principle is discussed in this paragraph. To simplify the explanation, the example used here is that of measuring an ideal capacitor. See Figure 8-2, Cp Measurement. During time T1, the integrator is charged by that portion of the E_2 sinusoidal waveform which is synchronously phase detected by the e_2 pulse train. Both S1 and S2 switches select the E1 signal that is fed to discharge the integrator after being phase-detected by the e_1 signal. Since time period T2, for the integrator to discharge to zero volts, is proportional to the value of Cx, Cx can be directly obtained from the contents of a counter if the values for Rr and T1 are properly and accurately set. Other measurements are done similar to the Cp measurement.

8-11. BLOCK DIAGRAM DISCUSSION.

8-12. Analog Block Diagram. Figure 8-3 is a detailed block diagram of the 4261A analog section. The construction of this diagram is based on the actual printed circuit board assembly. It is useful for troubleshooting.

8-13. A4 Oscillator and Range Resistor Board. Oscillator output is fed through an attenuator (A3R17, R18 and Q5) and a power amplifier to transformer T1. The oscillator output can only be attenuated (A3Q5 turned on) when a Cp measurement is being made. In all other measurements, A3Q5 never turns on. The oscillator signal from the secondary of T1 is provided via source resistor Ro to the unknown device (Cx in diagram). The current that flows through Cx also flows through range resistor Rr via the Range Resistor Amplifier. Ro and Rr are selected by a range control signal from the digital section. A note in Figure 8-3 describes how the resistors are controlled. The GUARD terminal is connected directly to the instrument chassis. The circuit common for all PC boards is also finally connected to the chassis. DC bias voltages up to +30 volts can be applied to the unknown device through A1S2 DC BIAS switch through A4R31, secondary wiring of T1, and Ro from A9 Power Supply (internal) or from an external dc bias source connected to EXT BIAS connectors on rear panel.

8-14. A5 Process Amplifier. Voltages across the unknown device and across Rr are inputs for this assembly which feeds e_{ref} signal (reference phase signal used for phase detection) and e_m signal (signal measured by the integrator) to A6 Board. The two input signals are selected according to specific measurement rules and are used as e_{ref} and e_m signals. The e_{ref} signal is chosen when the measurement circuit mode is selected. Setting the CIRCUIT MODE switch to PARA selects the voltage across Cx as the e_{ref} signal. The SER position of the CIRCUIT MODE switch selects the voltage across Rr as the e_{ref}. If the switch is set to AUTO, the e_{ref} signal selection is done automatically and applied in a manner similar to the above. The selected e_{ref} signal is amplified by A5U6A and is wave-shaped by A5U6B and U8 which also adjust the duty cycle of e_{ref} by a control input (APAO signal) from A6 Board.

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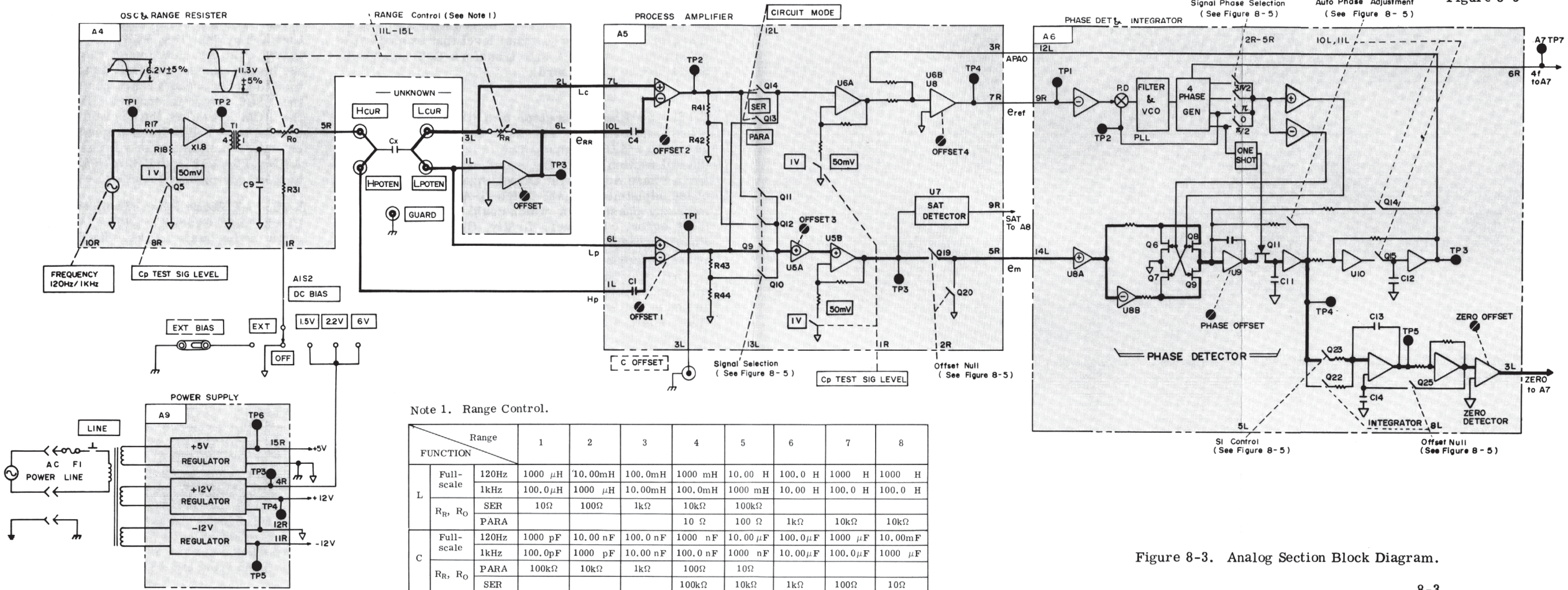

Note 1. Range Control.

FUNCTION		Range	1	2	3	4	5	6	7	8
L	Full-scale	120Hz	1000 μH	10.00mH	100.0mH	1000 mH	10.00 H	100.0 H	1000 H	1000 H
		1kHz	100.0μH	1000 μH	10.00mH	100.0mH	1000 mH	10.00 H	100.0 H	100.0 H
	R_R, R_O	SER	10Ω	100Ω	1kΩ	10kΩ	100kΩ			
		PARA				10 Ω	100 Ω	1kΩ	10kΩ	10kΩ
C	Full-scale	120Hz	1000 pF	10.00 nF	100.0 nF	1000 nF	10.00 μF	100.0μF	1000 μF	10.00mF
		1kHz	100.0pF	1000 pF	10.00 nF	100.0 nF	1000 nF	10.00μF	100.0μF	1000 μF
	R_R, R_O	PARA	100kΩ	10kΩ	1kΩ	100Ω	10Ω			
		SER				100kΩ	10kΩ	1kΩ	100Ω	10Ω
R	Full-scale	120/1kHz	1000 mΩ	10.00 Ω	100.0 Ω	1000 Ω	10.00 kΩ	100.0kΩ	1000 kΩ	10.00MΩ
	R_R, R_O	SER	10Ω	100Ω	1kΩ	10kΩ	100kΩ			
		PARA				10 Ω	100 Ω	1kΩ	10kΩ	100kΩ

Figure 8-3. Analog Section Block Diagram.

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The e_m signal is selected by FET switches A5Q9 thru Q12 which are, in turn, controlled by signal selection signals from the digital section. The method of selecting the e_m signal is graphically shown in Figure 8-5 Timing Diagrams. The selected e_m signal is amplified by A5U5A, U5B and becomes an input signal for the phase detector on A6 Board. C OFFSET signal on rear panel is a signal opposite in phase to the signal at the HCUR terminal. When Cp TEST SIG LEVEL switch is set to 50mV position, the gain of amplifier A5U6A, U5B is increased. An SAT Detector detects an e_m signal level that exceeds approximately ±5 volts and transfers SAT signals to digital section (A8 Board).

8-15. A6 Phase Detector and Integrator. In this board, the two input signals e_{ref} and e_m are converted to a ZERO signal which is fed to the A8 Board (digital Section). The e_m signal is used as an APAO (Auto Phase Adjustment Output) signal only when auto phase adjustment signal is fed to A6 Board to minimize any phase error which could cause a measurement error. However, firstly, e_{ref} is fed into the Phase Locked Loop (PLL) circuits consisting of a phase detector (PD), filter and VCO (voltage controlled oscillator) and is converted into four reference phase signals each being different by 90 degrees in phase one from the other. These four signals are individually selected by the digital circuitry and one is used as the phase detection signal for phase detector A6U6 thru U9 which phase detects the selected e_m signal. The dc output of the phase detector is applied to the integrator. The output of the integrator is monitored by the Zero Detector to observe the time that the zero level is crossed. This zero signal is sent to Digital Section (A7 Board) by Zero Detector. The output of the phase detector is also provided through A6U10, Q15, C12, etc. to A5 Board as an APAO (Auto Phase Adjustment Output) signal for the period of auto phase adjustment. All logic switches on this board are controlled by control signals from the digital section. See Figure 8-5 for details.

8-16. A9 Power Supply Board. This circuitry develops the dc power for the instrument. These voltages are the +5V, +12V and -12V. Internal dc bias voltages of 1.5V, 2.2V and 6V are also provided.

8-17. Digital Block Diagram. Figure 8-4 is the block diagram of the 4261A digital section. The construction of this diagram is based on the actual printed circuit board assembly. Thus, the diagram may be quite helpful when studying the function of an individual board or its schematic and trying to relate it to overall digital circuitry. In the following several paragraphs, each board assembly is described somewhat in detail.

8-18. A2 Display Board. This board displays the measured values with the measurement unit. All data signals, unit signals, circuit mode signals and the annunciation signal are sent from A3 Display Driver board which also provides anode driver signals to A2 Board to light the numeric displays.

8-19. A3 Display Driver Board. This board is divided into two parts, one of which is a numeric display driver (top left in Figure 8-4). The other circuit is a unit/circuit mode driver and range/phase decoder (right bottom in Figure 8-4). In the numeric display driver, the measured serial data from A7 Board is filed in A3U8 and U9 registers whose outputs are decoded into a data format suitable for lighting the 7-segment displays on the A2 Board; this is accomplished by the A3U1 and U2 decoders and the anode drive signals generated by A3U14 thru U16 and A3Q1 thru Q4 by inputting RSA and RSB signals from A7 Board. In the unit/circuit mode driver section of the board, decoder ROM U18 functions as a unit/circuit mode decoder and as a range control decoder only when the $\overline{\text{LSC0}}$ signal is enabled. During other periods, the ROM works as the decoder for phase selection control and V TEST signal generation. Information on unit/circuit mode and range is stored in latches A3U4, U6, U11 and U12 to hold the information for at least one measurement cycle.

8-20. A7 Clock Pulse Generator/Counter Board. Clock Pulse Generator (A7Y1, U1, U6 thru U8) consists of two state clocks, SCL1 and SCL2. Both clocks have a frequency of 127kHz but have a phase difference of 90 degrees to each other. The CPG also generates a 31.83kHz clock for the Data Counter and RSA/RSB signals used for data register/display and measurement control. In the Data Counter Gate circuit, either a 4f or a 31.83kHz signal is selected by the 4fS signal from A8 Board and sent to Data Counter as a clock pulse. The Data Counter Gate also generates an $\overline{\text{SI}}$ signal to control A6 Integrator. Data Counter counts the input clock pulses as directed by GATE, $\overline{\text{SDC}}$ and $\overline{\text{CDC}}$ control signals. A parallel to serial converter A7U21 and U12 converts parallel BCD data into serial BCD data by control of RSA and RSB signals and sends the data to register files in A3 Board. All input multiplexers (A7U10, U13, U18 and U19 on the A7 board and A8U12 and U6 on the A8 board) receive various data signals, control signals, measurement condition signals, etc., and provide outputs as directed and assigned by OPB8 thru OPB10 control signals. All multiplexer outputs are taken from the A8 board.

8-21. A8 Sequence Control Board. Output signals ($\overline{\text{MPX0}}$, MPX1, $\overline{\text{MPX2}}$, MPX3, MPX4 and $\overline{\text{MPX5}}$) from the six input multiplexers are applied to A8U1 Multiplexer which selects one of these input signals as directed by OPB11 thru OPB13 control signals. Multiplexer output is gated with OPB15 of A8U8, synchronized with SCL2 (State Clock 2) by A8U13 and becomes a qualifier input to State Counter/Register (A8U2, U7) which produces the input signals (IBP0 thru IPB7) to Control ROM U8 in synchronization with SCL1 (State Clock 1) from next address signal (OPB0 thru OPB7 of A8U8) and qualifier input signal. Control ROM A8U8 outputs OPB0 thru OPB15 which are used for next address signal, input multiplexer control signal, Multiplexer (A8U1) control signal and provides for various instruction outputs through Decoder (A8U17). The instruction outputs are control signals for both analog and digital circuitry.

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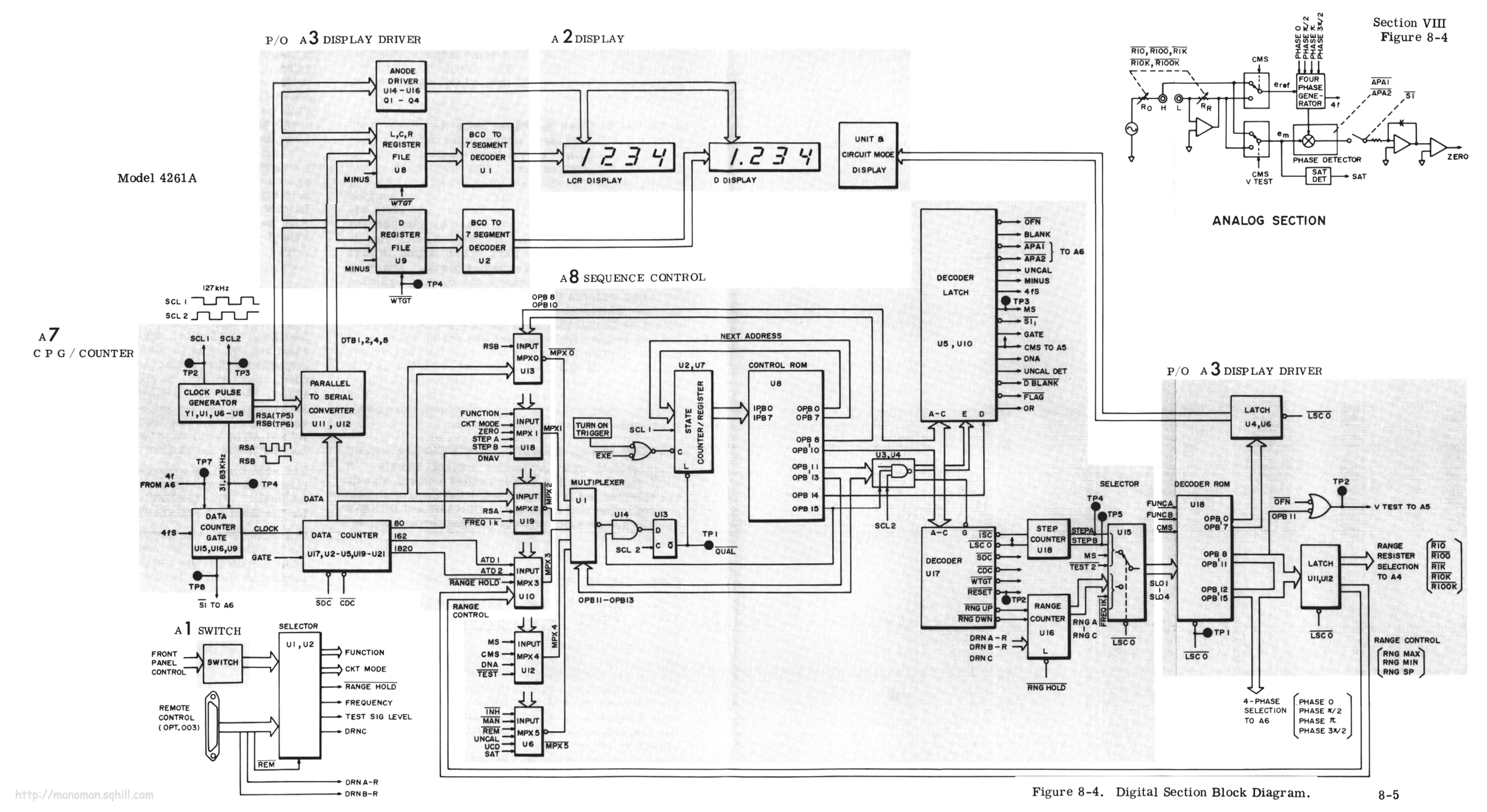

Figure 8-4. Digital Section Block Diagram.

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A8U18 is a Step Counter and determines measurement step. A8U16 Range Counter receives range control signals and outputs range signals (RNG A, RNG B, RNG C) to A8U15 Selector which selects range signals only when $\overline{\text{LSC0}}$ signal is enabled or step signals (STEP A, STEP B or some step combination) when $\overline{\text{LSC0}}$ is disabled. The outputs of A8U15 Selector are sent as SLO1 thru SLO4 signals to A3 Decoder ROM input.

8-22. ROM State Machine. Since the 4261A has adopted a ROM-centered design in the digital section (A3 and A8 boards), only a brief explanation for its operation is presented here. The state machine has a state address (code) that manages the operation of the ROM state machine. ROM output is determined by the address inputted to the ROM. The state address for A8 ROM U8 is determined by next address from the ROM output and qualifier input. And it should be noted that the ROM output signal is also utilized for the control of qualifier signal. The state address sometimes increases one by one, repeats the same address several times, or jumps to higher or lower addresses. For example, if some condition should be maintained for a certain period, the state address repeats the same address during the desired number of state clocks. In this case, the instruction output does not change. Note that the ROM used in the A3 board functions as a decoder which has no feedback from ROM output to the input. The ASM chart in Figure 8-6 is very convenient for understanding the ROM-centered circuits.

8-23. A10 Mother Board. includes a selector circuit which selects local or remote control signals. If $\overline{\text{REM}}$ signal is at low level, remote control signals are selected and if at high level, local control signals are fed to internal circuitry. DRNA-R and DRNB-R signals are provided without passing through the selector.

8-24. TIMING DIAGRAM DISCUSSION.

8-25. Figure 8-5 presents a timing diagram for the 4261A. Firstly, output waveforms of the integrator, excute time for each measurement sequence, and main control signals are shown in the upper part of the diagram. The sequence excute times are different for measurement frequencies of 120Hz and 1kHz since the electrical response time for the frequencies are different and a 4f signal (four times the measurement frequency) is sometimes used for determining the charging cycle. Note that the excute time for the discharge sequence is variable. As you can understand from the diagram, the instrument first measures the L/C or R value and then the Dissipation Factor (D). To minimize error, offset null and auto phase adjustment sequences precede the L/C and R measurements. Only an offset null sequence precedes a D measurement.

8-26. The lower part of the diagram shows how the analog circuits are controlled. Waveforms for the V TEST signal voltages (which control e_m voltage selection -- selecting either the voltage across Rr or the voltage across the UNKNOWN) and detection phase for phase detector on A6 board are shown for each circuit mode in the table in Figure 8-5. Both upper and lower sections of the waveform timing diagram have the same time scale. $-e_x$, $-e_x/10$, $-e_y$ and $-e_y/10$ in the e_m column are names for the voltages shown in diagram Note 2. The detection phases 0, $\pi/2$, π, or $3\pi/2$ are the same as the phase selection signals sent to the A6 board. The phase relationships of the voltages applied to phase detector FET switches A6Q6 and Q9 are shown in diagram Note 3 along with the phase of the e_{ref} signal at A6TP1. In R measurements, measurement steps 1 and 2 in D measurement cycle are skipped.

8-27. ASM (Algorithmic State Machine) Chart. Figure 8-6 is an ASM chart which is similar to a flow chart and describes all the digital operations, including, of course, analog circuit control. This chart can be read in almost the same manner as a conventional flow chart. The chart is probably best used, as necessary, in combination with Figure 8-4 Digital Section Block Diagram, Table 8-1 Mnemonic Information, and circuit schematics. The chart is essential in troubleshooting the digital circuits (A3, A7 and A8 boards), so it may be referred to throughout the following section on digital troubleshooting.

The ASM chart is a diagrammatic description of the output function and the next-state function of the state machine. The symbols used in the ASM chart are for the State Box and the Decision Box.

The ASM chart has three basic elements; the state, the qualifier and the conditional output. A single state is indicated by a state box which contains state outputs as noted in Figure 8-6.

The output consists of mnemonics selected from a defined set of operations. The mnemonics name outputs which are given during the state time. The exit path of the state box leads to other state boxes or to decision boxes.

The Decision Box describes inputs to the state machine. The structure of the decision box is given in Figure 8-6. Each decision box has two exit paths.

One path is taken when the condition is true and the other when the condition is false. These two paths are usually indicated by 1 for true and 0 for false. The inputs are also called qualifiers in the sense that they qualify an output or a transition.

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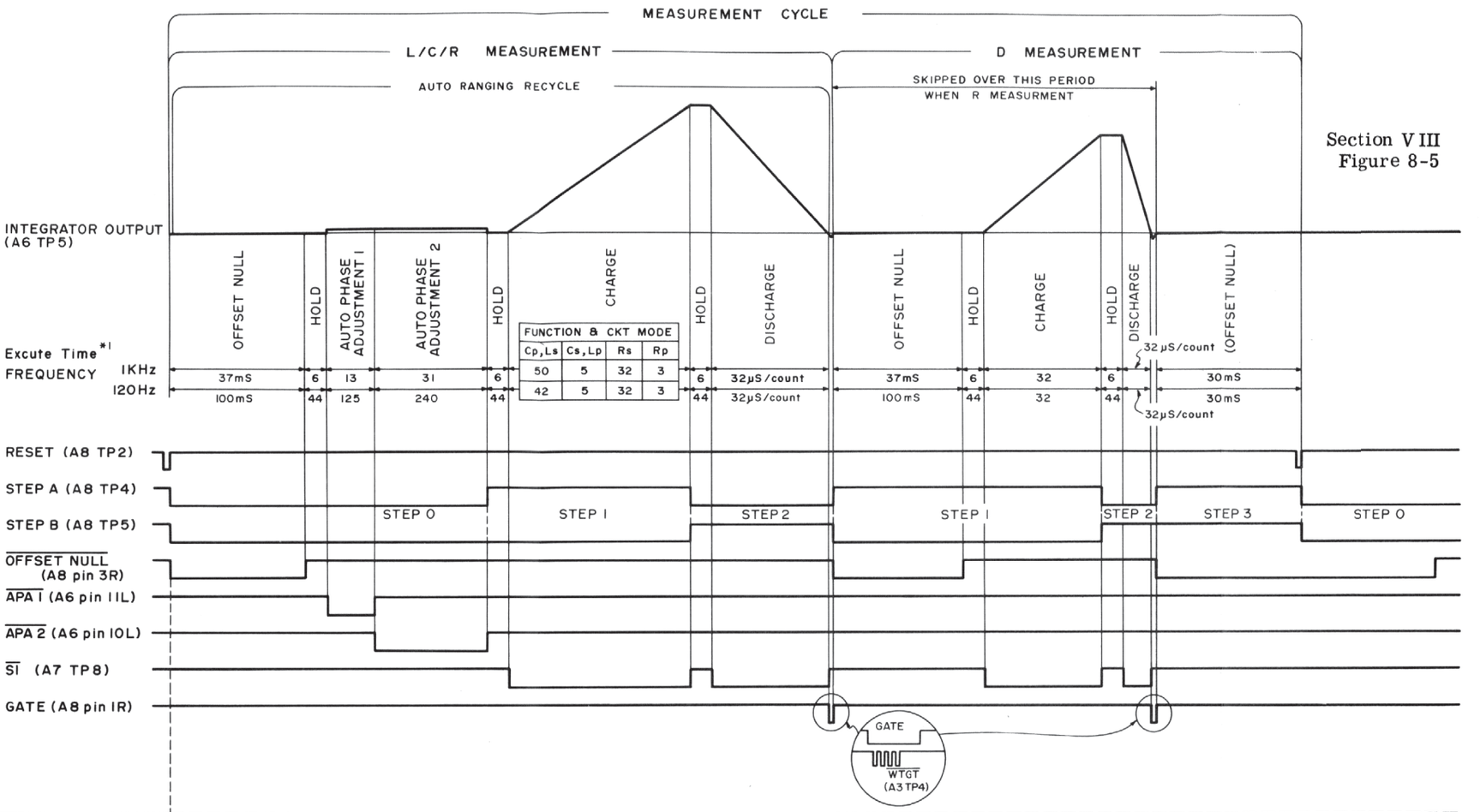
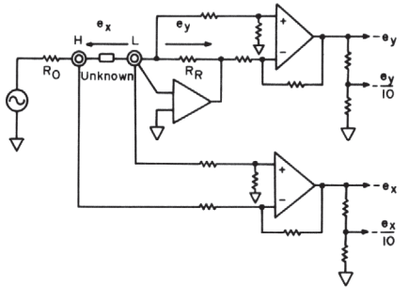
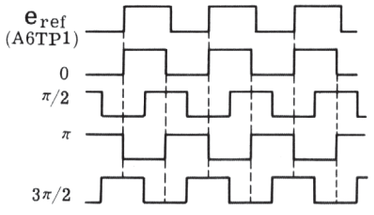


Note 1. Unit for excute time is msec except for discharge sequence.

Note 2. Selection of e_m.



Note 3. Phase for Phase Detector (A6Q6, Q9)



Ls,Cp	VTEST (A3 TP2)							
	e_m *2	Ls	$-e_x$	$-e_y/10$	$-e_x$	$-e_y/10$	$-e_x$	
		Cp	$-e_y$	$-e_x/10$	$-e_y$	$-e_x/10$	$-e_y$	
	Phase for Phase Detector (A6)*3			π/2		0	3 /2	π/2
Lp,Cs	VTEST (A3 TP2)							
	e_m *2	Cs	$-e_x$	$-e_y/10$		$-e_x$		
		Lp	$-e_y$	$-e_x/10$		$-e_y$		
	Phase for Phase Detector (A6)*3			π/2	π	π/2	0	π/2
Rs	VTEST (A3 TP2)							
	e_m *2	Rs	$-e_x$	$-e_y/10$	$-e_x$	$-e_y/10$		$-e_x$
	Phase for Phase Detector (A6)*3			π/2	π			π/2
Rp	VTEST (A3 TP2)							
	e_m *2	Rp	$-e_y$	$-e_x/10$		$-e_y$		$-e_y$
	Phase for Phase Detector (A6)*3			π/2	π			π/2

Figure 8-5. Timing Diagram.

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Table 8-1. Mnemonic Information (Sheet 1 of 2).

Mnemonic	Description	Mnemonic	Description
$\overline{\text{ALT}}$	select output data for LCR or D (OPT. 002)	DRNB	direct range setting, bit B
		DRNC	direct range setting, bit C
ANOD 1 thru ANOD 4	anode driver signal 1 for data display thru anode driver signal 4 for data display.	DRND	direct range setting, bit D
		DTB 1 thru DTB 8	data bit 1 from counter thru data bit 8 from counter
APAO	error output for auto phase adjustment	e_m (EM)	phase detector input voltage
$\overline{\text{APA 1}}$	perform 1st auto phase adjustment	e_{ref} (E REF)	AC reference phase signal
$\overline{\text{APA 2}}$	perform 2nd auto phase adjustment	e_{rr}	range resistor voltage
		$-e_x$ (-EX)	AC voltage for C OFFSET
ATD 1	detected output for 162 counts	$\overline{\text{EXE}}$	external encode signal
ATD 2	detected output for 1820 counts	EXT B (EXT BIAS)	external bias voltage
$\overline{\text{AUTRG}}$	enable local triggering when in remote control	$\overline{\text{FLAG}}$	flag signal to external device
BIAS	DC bias voltage	$\overline{\text{FREQ 1k}}$ ($\overline{\text{FREQ}}$)	set test signal frequency to 1kHz
BLANK	blank display		
B 1.5V	set internal bias voltage to 1.5V	FUNC A (FNC A)	function control, bit A
B 2.2V	set internal bias voltage to 2.2V	FUNC B (FNC B)	function control, bit B
		GATE	gate control signal for counter
$\overline{\text{C}}$	light "F" unit on front panel	Hp	voltage at H_{POTEN} terminal
$\overline{\text{CDC}}$	clear data counter	$\overline{\text{INH}}$	inhibit signal from external device
CL I	clock input		
CLO	clock output	INT B	internal bias voltage
CMA	circuit mode signal, bit A	$\overline{\text{ISC}}$	increment step counter
CMB	circuit mode signal, bit B	$\overline{\text{k}}$	light "k" on front panel
CMS	set circuit mode to series	$\overline{\text{L}}$	light unit "H" on front panel
$\overline{\text{CpRp}}$	light circuit mode indicator for Cp or Rp measurement	L'c	voltage at L'_{CUR} terminal
		Lp	voltage at L_{POTEN} terminal
$\overline{\text{C QAL}}$	clear qualifier flip-flop	$\overline{\text{L}_{PA}}$	light circuit mode indicator for Lp measurement
$\overline{\text{Cs}}$	light circuit mode indicator for Cs measurement	$\overline{\text{LSC 0}}$	load zero to step counter
CTEN	enable counter to count 4f signal	$\overline{\text{LSD a}}$ thru $\overline{\text{LSD g}}$	light segment "a" for left side numeric display thru light segment "g" for left side numeric display
$\overline{\text{D BLANK}}$	blank Dissipation Factor display		
DNA	generate $\overline{\text{D BLANK}}$ signal		
DNAV	detected output for less than 80 counts in Cp/Ls.	$\overline{\text{LsRs}}$	light circuit mode indicator for Ls or Rs measurement
$\overline{\text{DP b}}$	light decimal point for LCR display	$\overline{\text{M}}$	light "M" on front panel
$\overline{\text{DP c}}$	light decimal point for LCR display	$\overline{\text{m}}$	light "m" on front panel
$\overline{\text{DP-Loss}}$	light decimal point for Dissipation Factor display	$\overline{\text{MAN}}$	manual trigger signal from panel control.
		$\overline{\text{MINUS}}$	display minus (-) mark on front panel
DRNA	direct range setting, bit A		

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Table 8-1. Mnemonic Information (Sheet 2 of 2).

Mnemonic	Description	Mnemonic	Description
$\overline{\text{MPX 0}}$ thru MPX 5	multiplexer 0 output thru multiplexer 5 output	RSB	read select bit B for A3 register files
MS	measurement status. If D measurement, MS is at high.	$\overline{\text{RSD a}}$ thru $\overline{\text{RSD g}}$	light segment "a" for right side numeric display thru light segment "g" for right side numeric display
$\overline{\text{n}}$	light "n" on front panel	$\overline{\text{R100k}}$	set range resistor to 100kΩ
N2 - 4	output BCD signal, bit weight 4 for 2nd digit	$\overline{\text{R10k}}$	set range resistor to 10kΩ
		$\overline{\text{R1k}}$	set range resistor to 1kΩ
$\overline{\text{OFN}}$	perform auto offset null adjustment	$\overline{\text{R100}}$	set range resistor to 100Ω
OFNA	perform auto offset null adjustment	$\overline{\text{R10}}$	set range resistor to 10Ω
		SAT	signal indicating e_m saturation
OPB 0 thru OPB 15	output bit 0 from A8 ROM thru output bit 15 from A8 ROM	SCL 1	state clock 1
		SCL 2	state clock 2
OR	out of range	$\overline{\text{SDC}}$	set data counter to 1999
$\overline{\text{p}}$	light "p" on front panel	$\overline{\text{SI}}$	set integrator to function
		$\overline{\text{SI}_1}$, $\overline{\text{SI}_2}$	set integrator to function
PHASE 0 (PHB 1)	select 0 detection phase	SLO 1 thru SLO 4	selector output 1 from A8 thru selector output 4 from A8
PHASE $\pi/2$ (PHB 2)	select $\pi/2$ detection phase	$\overline{\text{S QAL}}$	set qualifier flip-flop
PHASE π (PHB 3)	select π detection phase	STEP A (STP A)	measurement step, bit A
PHASE $3\pi/2$ (PHB 4)	select $3\pi/2$ detection phase	STEP B (STP B)	measurement step, bit B
$\overline{\text{QUAL}}$	qualifier input to state counter/ register	$\overline{\text{TEST}}$	perform test operation
$\overline{\text{R}}$	light "Ω" unit on front panel	$\overline{\text{TEST 1}}$	perform test 1 sequence
REF V	reference voltage for bias voltages	$\overline{\text{TEST 2}}$	perform test 2 sequence
		TL	test level signal from A10
$\overline{\text{REM}}$	remote signal from external device	$\overline{\text{TLL}}$	set test signal level to 50mV
$\overline{\text{RESET}}$	turn off trigger lamp on front panel	$\overline{\text{TRG L}}$	light trigger lamp on front panel
		$\overline{\text{TOT}}$	turn-on trigger
RNG A	range signal, bit A	UCD	detected output for UNCAL signal
RNG B	range signal, bit B		
RNG C	range signal, bit C	UNCAL	detected output for SAT signal
RNG DWN	step down one decade range	V TEST	select signal for e_m by working with CMS
$\overline{\text{RNG HOLD}}$	hold measurement range		
RNG MAX	maximum range signal	$\overline{\text{WTGT}}$	enable data transfer
RNG MIN	minimum range signal	$\overline{\text{ZERO}}$	zero detector output
RNG SP	special range that 4261A does not measure	$\overline{\mu}$	light "μ" on front panel
RNG UP	step up one decade range	4f (4F)	clock 4 times test frequency
RSA	read select bit A for A3 register files	4fs	set 4f signal as clock to counter

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Table 8-2. ASM Chart Check Procedures (Sheet 1 of 16).

Note

If 4261A settings are not specified in this table, any setting is acceptable except that TRIGGER must be set to INT and RANGE HOLD must be set to OFF.

State code is expressed in the octal system. It is recommended that the logic state analyzer be operated in the single trigger mode. Unless otherwise noted, the "start display" trigger word is given in the "Trigger Word for Logic State Analyzer" column of the table.

Sequence Check for ① INITIAL SETUP TIME.

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
Normal (not Self Test) Operation		
Any settings Push 4261A RESET	001	001 002 003 004 005 006 007 010 011 037
CIRCUIT MODE: PARA	037	037 040 041 035 013
CIRCUIT MODE: SER	037	037 040 055
CIRCUIT MODE: AUTO FUNCTION: C Unknown: Open	037	037 042 043 046 047 050 013
CIRCUIT MODE: AUTO FUNCTION: C Unknown: Shorted	043	043 044 051 052 013
CIRCUIT MODE: AUTO FUNCTION: R Unknown: Shorted	043	043 046 052 013
CIRCUIT MODE: AUTO FUNCTION: L Unknown: Open	043	043 044 051 047 050 013

(Continued)

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Table 8-2. ASM Chart Check Procedures (Sheet 2 of 16).

Sequence Check for ① INITIAL SETUP TIME (Cont'd)

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
CIRCUIT MODE: AUTO FUNCTION: L, C or R Unknown: in-range component (do not use max. or min. ranges).	043	043 044 045 013
1. RANGE HOLD: OFF TRIGGER: INT 2. CIRCUIT MODE: SER FUNCTION: C Unknown: Open 3. RANGE HOLD: ON TRIGGER: EXT 4. CIRCUIT MODE: AUTO Push RESET for LSA. 5. Change FUNCTION C to L.	043	043 046 052 053 054 055 035
1. RANGE HOLD: OFF TRIGGER: INT 2. CIRCUIT MODE: PARA FUNCTION: C Unknown: Short 3. RANGE HOLD: ON TRIGGER: EXT 4. CIRCUIT MODE: AUTO Push RESET for LSA. 5. Change FUNCTION C to L.	043	043 044 051 047 053 054 041 035
1. TRIGGER: INT RANGE HOLD: OFF CIRCUIT MODE: AUTO FUNCTION: C Unknown: Open TRIGGER: EXT Push RESET for LSA 2. Change FUNCTION C to L.	042	042 053 054 055 035
Self Test Operation TEST 1, TRIGGER: INT RANGE HOLD: OFF	011	011 012 013
TEST 2 FUNCTION: C RANGE HOLD: OFF TRIGGER: INT	011	011 012 031 032 034 036 035

(Continued)

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Table 8-2. ASM Chart Check Procedures (Sheet 3 of 16).

Sequence Check for ① INITIAL SETUP TIME (Cont'd)

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
TEST 2 FUNCTION: L RANGE HOLD: ON TRIGGER: INT	011	011 012 031 033 034 035

Sequence Check for ② AUTO OFFSET NULL TIME.

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
Normal Operation		
FREQUENCY: 1kHz	013	013 014 015 016 020
FREQUENCY: 120Hz	016	016 017 017
	020 End Display	017 020
FREQUENCY: 1kHz	020 End Display	020 020 021 022
FUNCTION: C CIRCUIT MODE: PARA Unknown: Shorted	022	022 024 025 027 030 025
FUNCTION: C CIRCUIT MODE: PARA Unknown: Open Note: Push RESET for LSA several times.	022	022 024 025 027 025
	056 End Display	025 026 056
Test Operation		
TEST 1	022	022 023 026 056

Sequence Check for ③ HOLD TIME

FREQUENCY: 1kHz	056	056 057 063 063
	064 End Display	063 064

(Continued)

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Table 8-2. ASM Chart Check Procedures (Sheet 4 of 16).

Sequence Check for ③ HOLD TIME (Cont'd)

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
FREQUENCY: 120Hz	057	057 060 060
	061 End Display	060 061
	064 End Display	061 061 062 064
	064	064 175
		064 065 066
Note: Push RESET for LSA several times. The state code order should be as shown in the three blocks to the right.		064 065 114 141
FUNCTION: R CIRCUIT MODE: SER Note: Push RESET for LSA several times	141	141 142 143 162 117 120
FUNCTION: R CIRCUIT MODE: PARA	143	143 162 163 164
FUNCTION: C CIRCUIT MODE: PARA FREQUENCY: 120Hz	143	143 144 145 146 147
FUNCTION: C CIRCUIT MODE: PARA FREQUENCY: 1kHz	143	143 144 145 166 167
FUNCTION: C CIRCUIT MODE: SER FREQUENCY: 120Hz	143	143 144 154 155 156
FUNCTION: C CIRCUIT MODE: SER FREQUENCY: 1kHz	143	143 144 154 146 147
FUNCTION: L CIRCUIT MODE: PARA	141	141 142 153 154

(Continued)

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Table 8-2. ASM Chart Check Procedures (Sheet 5 of 16).

Sequence Check for (3) HOLD TIME (Cont'd)

4261A Settings	Trigger Work for Logic State Analyzer (HP 1601A)	State Code Order
FUNCTION: L CIRCUIT MODE: SER Unknown: Short	141	141 142 153 145
Note: Push RESET for LSA several times.	117 End Display	114 141 117
FUNCTION: R CIRCUIT MODE: SER	056 End Display	120 120 121 174 056
FUNCTION: R CIRCUIT MODE: PARA	174 End Display	164 164 165 174
FUNCTION: C CIRCUIT MODE: PARA FREQUENCY: 1kHz	171 End Display	167 167 170 171
	173 End Display	171 171 172 173
	174 End Display	173 173 174
FUNCTION: C CIRCUIT MODE: PARA FREQUENCY: 120Hz	151 End Display	147 147 150 151
	173 End Display	151 151 152 173
FUNCTION: C CIRCUIT MODE: SER FREQUENCY: 120Hz	160 End Display	156 156 157 160
	173 End Display	160 160 161 173
Test Operation		
TEST 1	114	114 115 116
TEST 2	114	114 115 117

(Continued)

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Table 8-2. ASM Chart Check Procedures (Sheet 6 of 16).

Sequence Check for (4) AUTO PHASE ADJUSTMENT TIME

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
Normal Operation FREQUENCY: 120Hz	066	066 067 070 071 071
	073 End Display	071 072 073
	101 End Display	073 073 074 076 077 100 101
FREQUENCY: 1kHz	070	070 075
	076 End Display	075 075 076
	113 End Display	101 101 102 112 113
FREQUENCY: 120Hz	103 End Display	101 102 103 103
	105 End Display	103 104 105
	107 End Display	105 105 106 107
	111 End Display	107 107 110 111
	056 End Display	111 111 112 113 056

(Continued)

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Table 8-2. ASM Chart Check Procedures (Sheet 7 of 16).

Sequence Check for (5) DISCHARGE TIME.

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
Normal Operation		
FUNCTION: C CIRCUIT MODE: PARA Unknown: Open Note: Check that 4261A is not displaying minus (-).	175	175 176 177 200 201 202 203 204
	212 End Display	204 203 205 206 212
FUNCTION: C CIRCUIT MODE: SER Unknown: Open	212 End Display	203 204 205 206 212
FUNCTION: L CIRCUIT MODE: AUTO Unknown: capacitor of a few μF. Note: Check that 4261A is displaying minus (-).	212 End Display	201 207 210 211 212
FUNCTION: C CIRCUIT MODE: SER Unknown: Open Note: Two code orders should be displayed on LSA. Push RESET for LSA several times.	212	212 213 224 226 257 260 212 213 224 226 257 227
RANGE HOLD: ON	212	212 213 224 226 227
Test Operation		
TEST 1	212	212 213 214
TEST 2	212	212 213 224 225 227

(Continued)

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Table 8-2. ASM Chart Check Procedures (Sheet 8 of 16).

Sequence Check for (6) AUTORANGING TIME

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
Normal Operation FUNCTION: C CIRCUIT MODE: PARA FREQUENCY: 120Hz Unknown: Open	260	260 261 270 271 272 305 227
FUNCTION: C CIRCUIT MODE: SER Unknown: Open	260	260 261 262 263 305 227
FUNCTION: R CIRCUIT MODE: SER Unknown: Open	261	261 262 304 264 227
FUNCTION: R CIRCUIT MODE: PARA Unknown: Open	261	261 270 276 301 302 264 227
FUNCTION: C CIRCUIT MODE: PARA Unknown: Short	261	261 262 263 264 227
FUNCTION: C CIRCUIT MODE: SER Unknown: Shorted	261	261 270 276 277 302 264
FUNCTION: L CIRCUIT MODE: PARA Unknown: Shorted	261	261 262 304 305
1. FUNCTION: C CIRCUIT MODE: PARA Unknown: Open 2. TIRGGER: EXT RANGE HOLD: ON 3. Unknown: Shorted Push RESET for LSA. 4. RANGE HOLD: OFF	261	261 262 263 264 265 010

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Table 8-2. ASM Chart Check Procedures (Sheet 9 of 16).

Sequence Check for (6) AUTORANGING TIME (Cont'd)

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
FUNCTION: C CIRCUIT MODE: SER Unknown: 100Ω <, <1kΩ	277	277 302 303 227
1. FUNCTION: C CIRCUIT MODE: PARA Unknown: Open 2. RANGE HOLD: ON 3. Unknown: 2000pF 4. Push RESET for LSA. RANGE HOLD: OFF	276	276 277 300 264
1. FUNCTION: R CIRCUIT MODE: PARA Unknown: Shorted 2. RANGE HOLD: ON 3. Unknown: 2kΩ 4. Push RESET for LSA. RANGE HOLD: OFF	276	276 301 302 264
1. FUNCTION: C CIRCUIT MODE: SER Unknown: Shorted 2. TRIGGER: EXT RANGE HOLD: ON 3. Unknown: Open Push RESET for LSA. 4. RANGE HOLD: OFF	261	261 262 263 305 306 010
FUNCTION: C CIRCUIT MODE: PARA Unknown: approx. 1000pF	261	261 270 271 227
1. FUNCTION: C CIRCUIT MODE: PARA Unknown: Open 2. RANGE HOLD: ON TRIGGER: EXT 3. Push RESET for LSA. 4. CIRCUIT MODE: SER RANGE HOLD: OFF	260	260 266 267 304

(Continued)

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Table 8-2. ASM Chart Check Procedures (Sheet 10 of 16).

Sequence Check for ⑥ AUTORANGING TIME (Cont'd)

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
1. FUNCTION: L CIRCUIT MODE: SER Unknown: Shorted 2. TRIGGER: EXT RANGE HOLD: ON 3. Push RESET for LSA. 4. CIRCUIT MODE: PARA RANGE HOLD: OFF	260	260 266 263
FUNCTION: C CIRCUIT MODE: PARA Unknown: more than 1kΩ	272	272 273 274 275 227
FUNCTION: L CIRCUIT MODE: SER Unknown: 10Ω<, < 1kΩ	273	273 307 227
1. FUNCTION: L CIRCUIT MODE: AUTO Unknown: more than 1kΩ 2. TRIGGER: EXT 3. Push RESET for LSA. 4. CIRCUIT MODE: PARA	301	301 302 303 227
1. FUNCTION: C CIRCUIT MODE: SER Unknown: Shorted 2. RANGE HOLD: ON 3. Unknown: approx. 0.1μF, 1μF or 10μF 4. Push RESET for LSA. 5. RANGE HOLD: OFF	273	273 274 305
1. FUNCTION: L CIRCUIT MODE: PARA Unknown: Open 2. RANGE HOLD: ON 3. Unknown: approx. 10mH, 100mH or 1000mH 4. Push RESET for LSA. 5. RANGE HOLD: OFF	273	273 307 310 305

(Continued)

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Table 8-2. ASM Chart Check Procedures (Sheet 11 of 16).

Sequence Check for (7) DNA DETECTION TIME

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
Normal Operation FUNCTION: R CIRCUIT MODE: SER Unknown: Shorted	227	227 230 244 245 246 247 237 242 243 311
1. FUNCTION: R CIRCUIT MODE: SER Unknown: Shorted 2. RANGE HOLD: ON 3. CIRCUIT MODE: PARA	246	246 256 240 241 311
FUNCTION: R CIRCUIT MODE: SER Unknown: Open	246	246 247 250 240
FUNCTION: L CIRCUIT MODE: SER Unknown: Open	244	244 or 251 232 233 234 235 236 240 244 251 232 253 254 235 236 240
FUNCTION: L CIRCUIT MODE: PARA Unknown: Shorted	244	244 251 252 233 234 235
FUNCTION: C CIRCUIT MODE: PARA Unknown: Open	230	230 231 232 253 254 235 237 242
FUNCTION: C CIRCUIT MODE: SER Unknown: Shorted	230	230 231 252 253 254
FUNCTION: C CIRCUIT MODE: SER Unknown: Shorted Note: Push RESET for LSA several times	237	237 240

(Continued)

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Table 8-2. ASM Chart Check Procedures (Sheet 12 of 16).

Sequence Check for (7) DNA DETECTION (Cont'd)

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
1. FUNCTION: C CIRCUIT MODE: PARA Unknown: Open 2. RANGE HOLD: ON 3. Unknown: Short	232	232 233 234
1. FUNCTION: L CIRCUIT MODE: SER Unknown: Shorted 2. RANGE HOLD: ON 3. CIRCUIT MODE: PARA	252	252 233 234 256 240
1. FUNCTION: C CIRCUIT MODE: SER Unknown: Shorted 2. RANGE HOLD: ON 3. CIRCUIT MODE: PARA	253	253 255 256
FUNCTION: C CIRCUIT MODE: PARA Unknown: Shorted Note: Push RESET for LSA several times.	234 End Display	227 234
FUNCTION: C CIRCUIT MODE: PARA Unknown: capacitor of approx. 1000pF. Check that D value is displayed on front panel. Note: Push RESET for LSA several times.	227	227 234 235 237 242 311

Sequence Check for (8) DISPLAY TIME

Normal Operation		
FUNCTION: C CIRCUIT MODE: PARA Unknown: Open	312 End Display	311 311 312
	315 End Display	312 313 312 314 315
	317 End Display	315 315 316 317
	321 End Display	317 317 320 321

(Continued)

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Table 8-2. ASM Chart Check Procedures (Sheet 13 of 16).

Sequence Check for ⑧ DISPLAY TIME(Cont'd)

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
*FUNCTION: R CIRCUIT MODE: SER Unknown: Shorted	241 End Display	321 322 323 324 325 336 337 241
*FUNCTION: C CIRCUIT MODE: PARA Unknown: Shorted	325 End Display	325 326 330 331
**FUNCTION: R	241 End Display	321 321 322 323 324 325 336 337 241
**FUNCTION: C CIRCUIT MODE: SER Unknown: Open	324	324 325 326 330 374 375 013
**1. FUNCTION: C CIRCUIT MODE: SER Unknown: Open 2. Shortcircuit jumper wire W1 on A8 board	324	324 325 326 330 331 336
FUNCTION: C CIRCUIT MODE: PARA Unknown: Shorted	340 End Display	323 332 333 334 335 340
1. FUNCTION: C CIRCUIT MODE: SER Unknown: Shorted 2. RANGE HOLD: ON 3. CIRCUIT MODE: PARA	340 End Display	323 332 334 335 340
FUNCTION: C CIRCUIT MODE: PARA Unknown: Open	340 End Display	333 334 340

Note: Perform tests marked "*" only for units serialed 1545J-00400 and below (instead of test marked "**").

(Continued)

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Table 8-2. ASM Chart Check Procedures (Sheet 14 of 16).

Sequence Check for (8) DISPLAY TIME (Cont'd).

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
Test Operation		
TEST 1	325	325 326 327 214

Sequence Check for (9) DATA TRANSFER TIME

Normal Operation		
FUNCTION: C CIRCUIT MODE: AUTO	340	340 341 342 343 344 345
	347 End Display	345 345 346 347
	352 End Display	347 350 351 352
	357 End Display	352 353 355 357
Note: Push RESET for LSA several times.	004 End Display	357 357 360 004
Test Operation		
TEST 1	361 End Display	355 356 361
TEST 2 RANGE HOLD: ON	357 End Display	355 356 357

Sequence Check for (10) TEST 1 & TEST 2

Test Operation		
TEST 1 FREQUENCY: 1kHz	361	361 362 363 366
	370 End Display	366 366 367 370
	372 End Display	370 370 371 372

(Continued)

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Table 8-2. ASM Chart Check Procedures (Sheet 15 of 16).

Sequence Check for ⑩ TEST 1 & TEST 2(Cont'd)

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
Test Operation		
TEST 1 (Cont'd) FREQUENCY: 1kHz Note: push RESET for LSA several times.	004 End Display	372 372 373 004
TEST 1 FREQUENCY: 120Hz	364 End Display	362 363 364
	371 End Display	364 364 365 371

Sequence Check for ⑪ TEST 1

Test Operation		
TEST 1 FUNCTION: C CIRCUIT MODE: PARA Unknown: Open	116	116 122 123 124 134 137 140 117
1. TEST 1 FUNCTION: C TRIGGER: EXT 2. Push MANUAL button until 4261A displays 1888μF. 3. Push RESET for LSA. 4. Push MANUAL.	123	123 127 130 134
1. TEST 1 FUNCTION: L TRIGGER: EXT 2. Push MANUAL until 4261A display 1888mH. 3. Push RESET for LSA. 4. Push MANUAL.	123	123 127 133 135 136 137
1. TEST 1 FUNCTION: C TRIGGER: EXT 2. Push MANUAL until 4261A display 1888nF (Cp). 3. Push RESET for LSA. 4. Push MANUAL.	123	123 127 130 131 132 137

(Continued)

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Table 8-2. ASM Chart Check Procedures (Sheet 16 of 16)

Sequence Check for ⑪ TEST 1 (Cont'd).

4261A Settings	Trigger Word for Logic State Analyzer (HP 1601A)	State Code Order
1. TEST 1 FUNCTION: L FREQUENCY: 1kHz TRIGGER: EXT 2. Push MANUAL until 4261A display 188.8H 3. Push MANUAL one more time. 4261A still displays 188.8H. 4. Push RESET for LSA. 5. Push MANUAL.	123	123 127 133 134 137
1. TEST 1 FUNCTION: L FREQUENCY: 1kHz TRIGGER: EXT 2. Push MANUAL until 4261A displays no numeric display. 3. Push RESET for LSA. 4. Push MANUAL.	122	122 125 126 137
1. TEST 1 FUNCTION: C FREQUENCY: 1kHz TRIGGER: EXT 2. Push MANUAL until 4261A displays no numeric displays. 3. Push RESET for LSA. 4. Push MANUAL.	122	122 125 136 137
TEST 1 RANGE HOLD: ON	116	116 117

Sequence Check for ⑫ TEST 1

Test Operation		
TEST 1	214	214 215 216
	217 End Display	216 216 127
	220 End Display	217 217 220
	221 End Display	220 220 221
	227 End Display	221 221 222 223 227

(Continued)

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Digital Section Troubleshooting Using Logic State Analyzer.

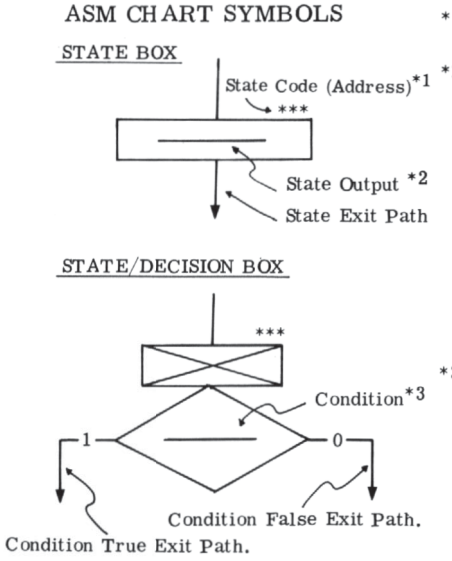
A logic state analyzer (for example the HP 1601A or 1600A) is very convenient for troubleshooting the 4261A ROM centered (state machine) logic circuitry. Figure 8-6 and Table 8-2 are provided to assist you in this kind of troubleshooting. Figure 8-6 is complete set of flow diagrams (ASM charts) for the 4261A. It also includes summarized flow diagrams for normal, Test 1, and Test 2 operations. Table 8-2 provides ASM chart check procedures that test all the flows included in Figure 8-6. Troubleshooting, using the logic state analyzer, should be done after the defective component is isolated to the digital section.

How to connect logic state analyzer to the 4261A: Although data inputs can be monitored directly at the pins of A8U8 (input address bits IPB0 thru IPB7) using the input probes of the logic state analyzer, it is recommended that the Service Cable (HP P/N: 04261-65001) be connected to the spare jack (A8J1) on the A8 board and logic state analyzer input probes be connected to each cable line (see Figure 8-14). Clock inputs should be taken from A7TP2 (state clock 1).

How to troubleshoot: When the measurement is being repeated (trigger lamp turns on and off), first set the trigger word to 004 in octal and check the ASM chart. Then repeat the test, increasing the trigger word, so that the measurement sequence is excuted according to the front panel conditions (control settings, displays and the unknown device). The trouble may be located in the circuit corresponding with the signal that generates the flow that is inconsistent with front panel conditions.

If the measurement can not be repeated, set 4261A TRIGGER to EXT and the logic state analyzer SAMPLE MODE to SINGLE. The logic state analyzer can now check that the flow shown in the ASM chart block (① thru ⑫ in Figure 8-6) is or is not being excuted when the trigger word is set to the last word of the chart block and the 4261A MANUAL button is operated (the trigger word will be displayed on the logic state analyzer if the chart block is properly excuted). By doing this check, starting from ASM chart block ①, the trouble may be in the logic circuitry that corresponds to the chart block which does not excute. Locate that line in the abnormal chart block that halts the sequence. Check the circuitry that corresponds to the signal that halts the sequence.

Note



*1. State code is represented in the octal system.

*2. State output signals are those outputted from A8U5, U10 and U17, and expressed, for example, as follows:

STATE OUTPUT	DESCRIPTION
S FLAG	Set FLAG signal output to its true level.
C FLAG	Clear FLAG signal output to its false level.
(LSC 0)	Pulsed LSC 0 output signal to load zero to step counter.

*3. Condition (signal in decision box) is the signal inputted into A8U1 multiplexer. State code is incremented by one when $\overline{\text{QUAL}}$ (qualifier) signal at A8TP1 is at high level ("0" is denoted in the chart), and remains at or jumps if $\overline{\text{QUAL}}$ signal is at low ("1" is denoted in the chart).

Shadowed part of ASM chart is excuted only during TEST 1 or TEST 2 operations.

Figure 8-6. ASM Chart (Sheet 1 of 7).

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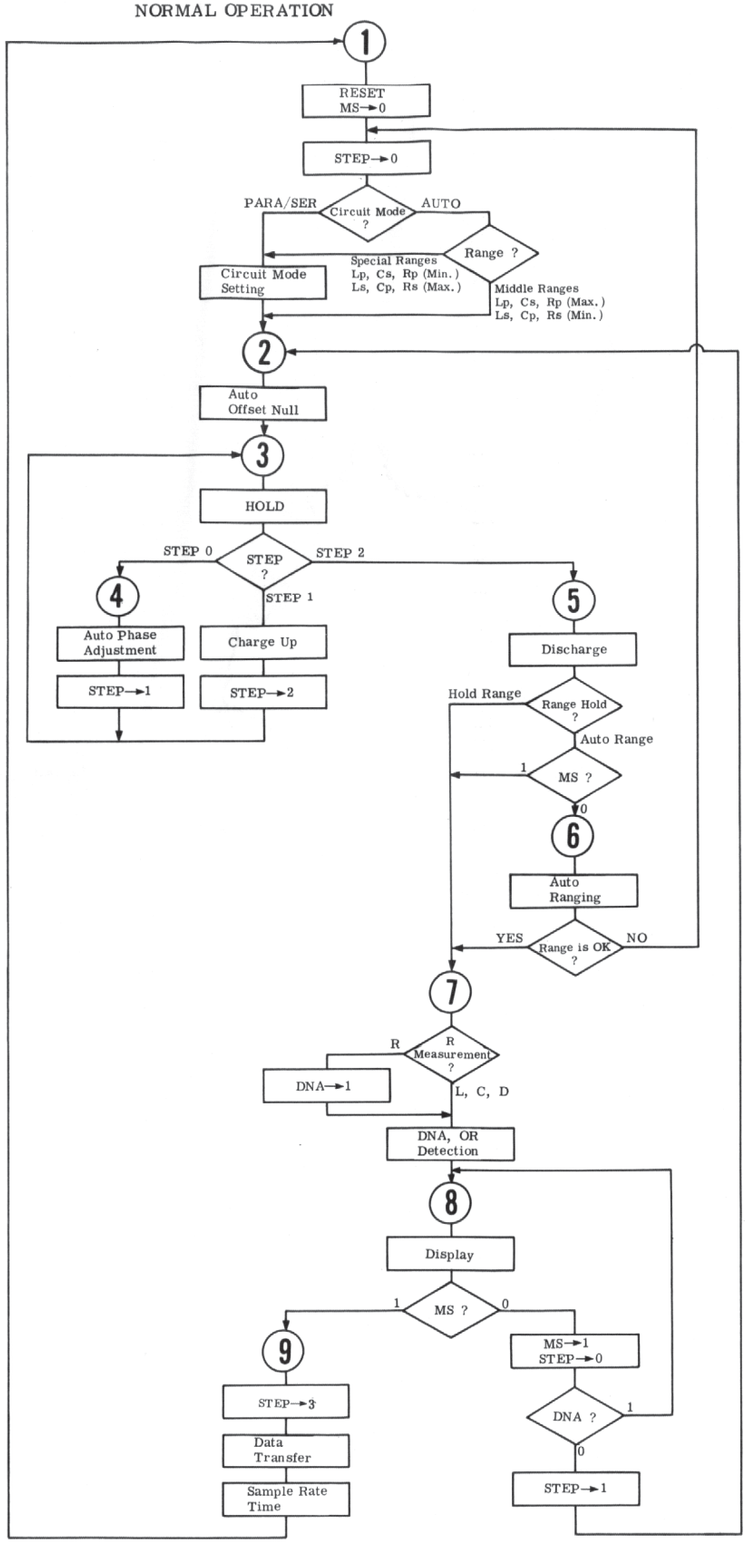
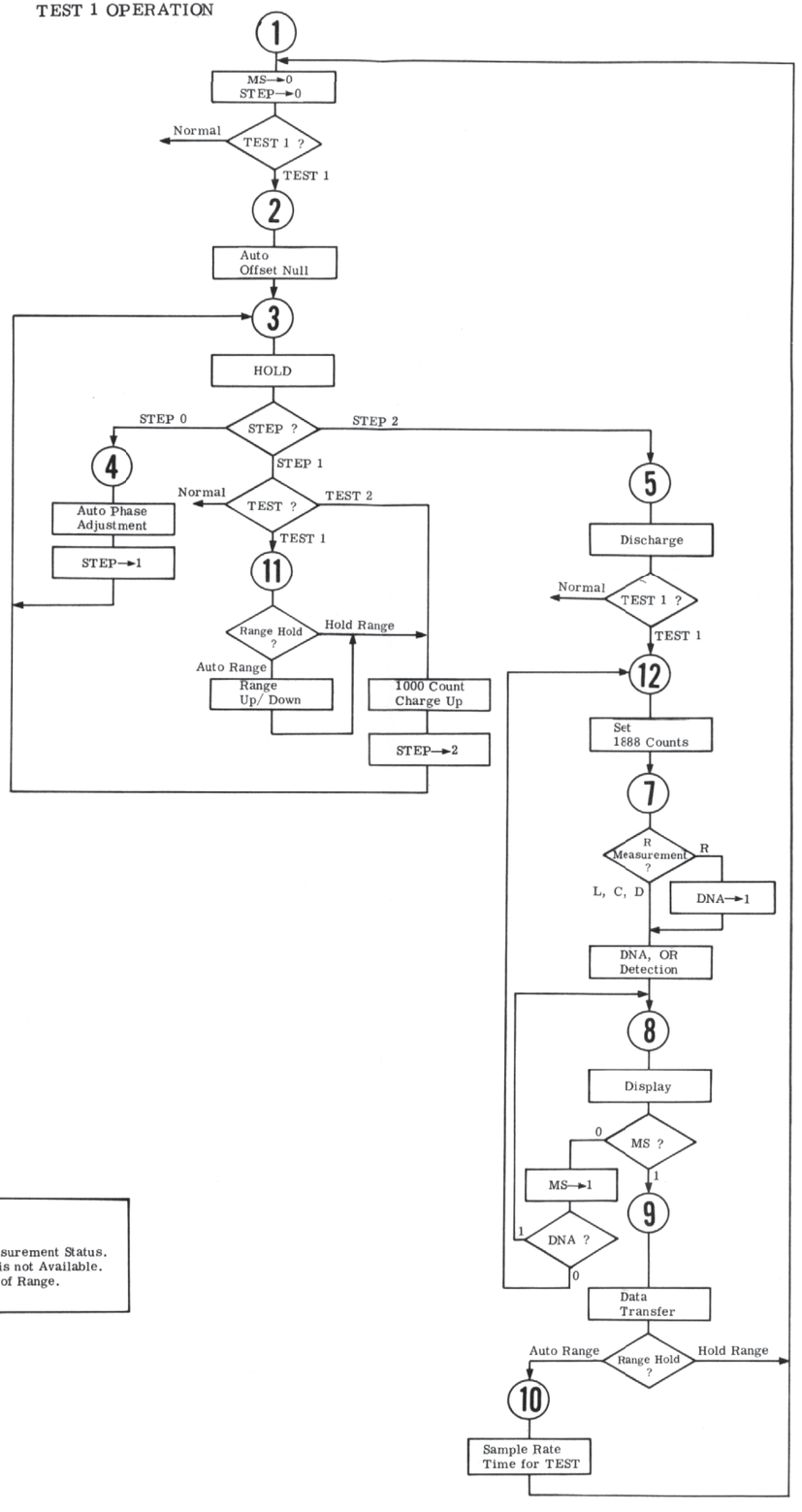
NORMAL OPERATION



TEST 1 OPERATION



Note:
MS: Measurement Status.
DNA: D is not Available.
OR: Out of Range.

TEST 2 OPERATION

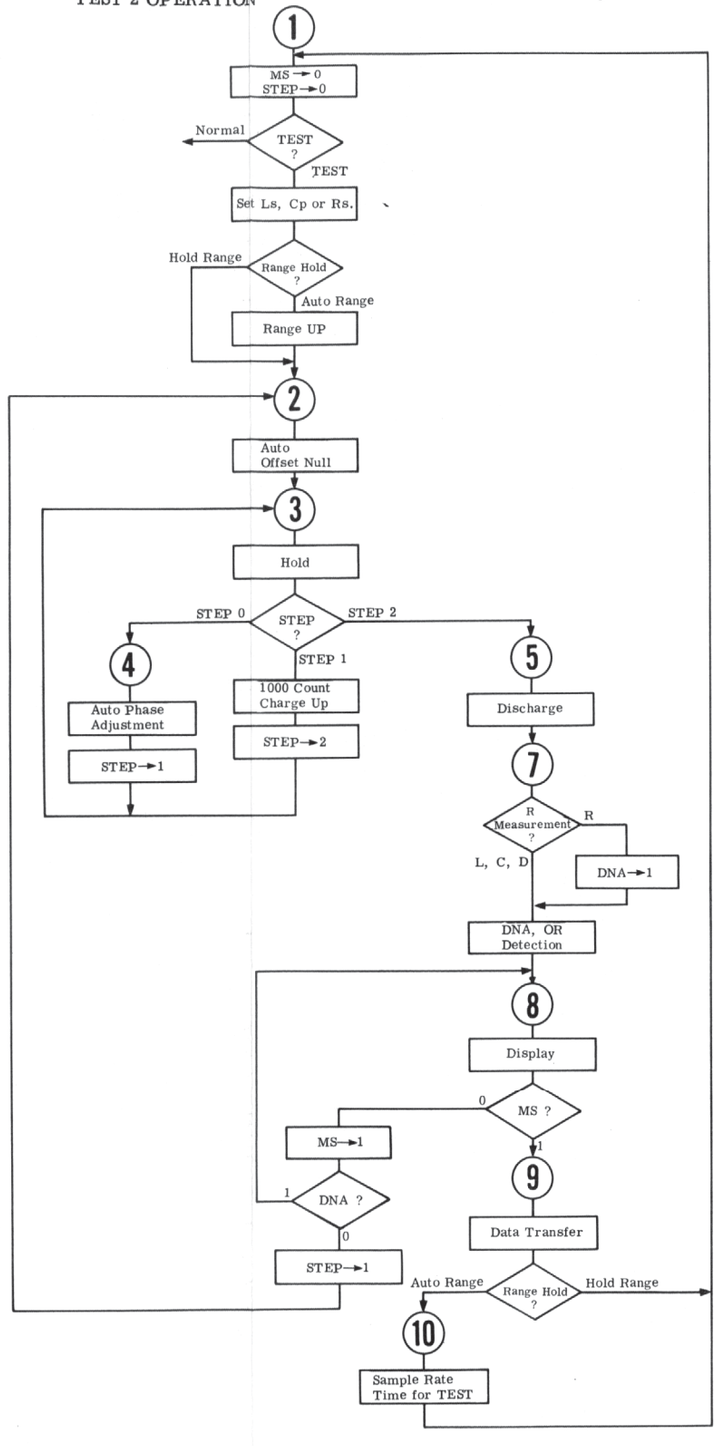


Figure 8-6. ASM Chart (Sheet 2 of 7).

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INITIAL CONDITION SETUP

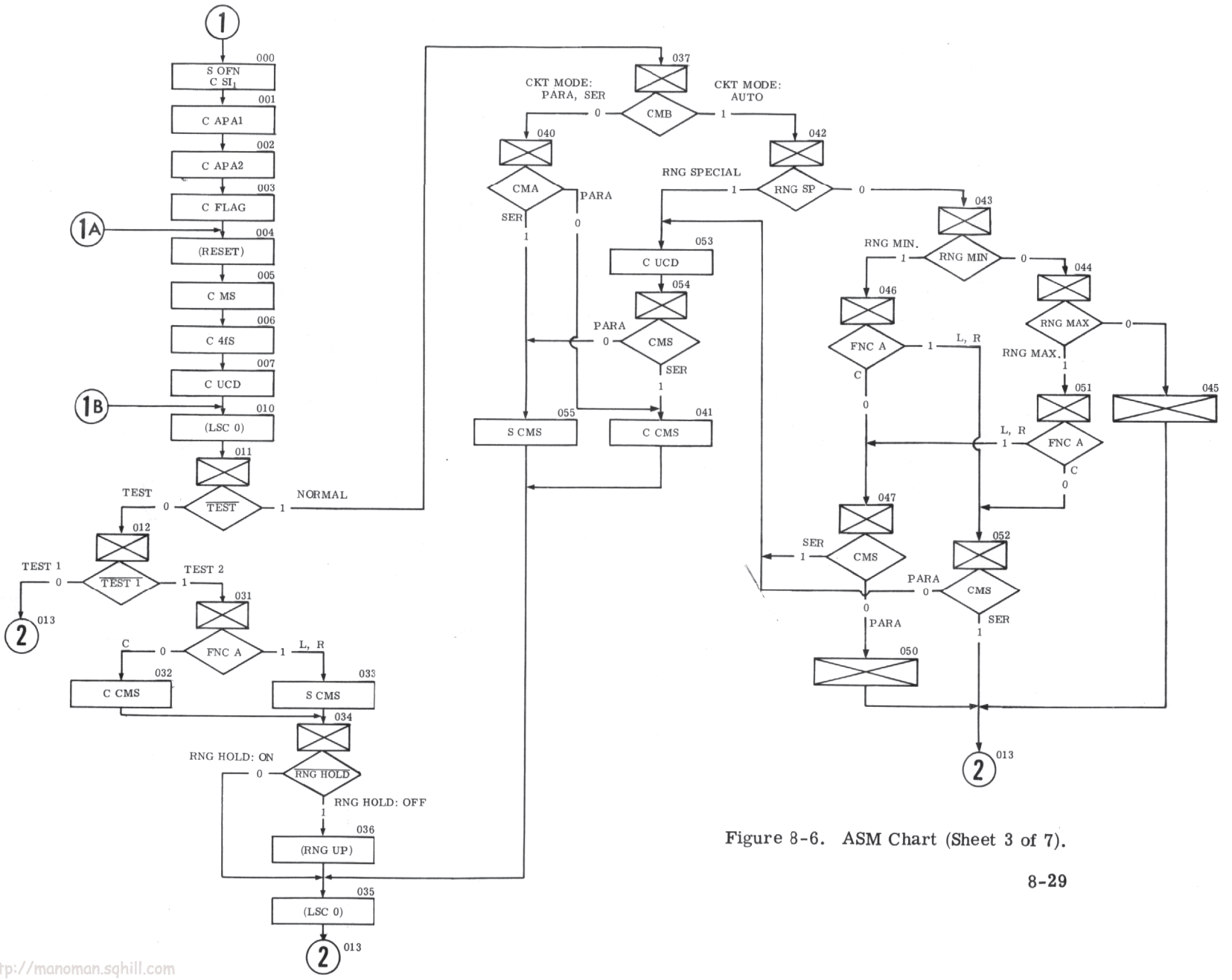
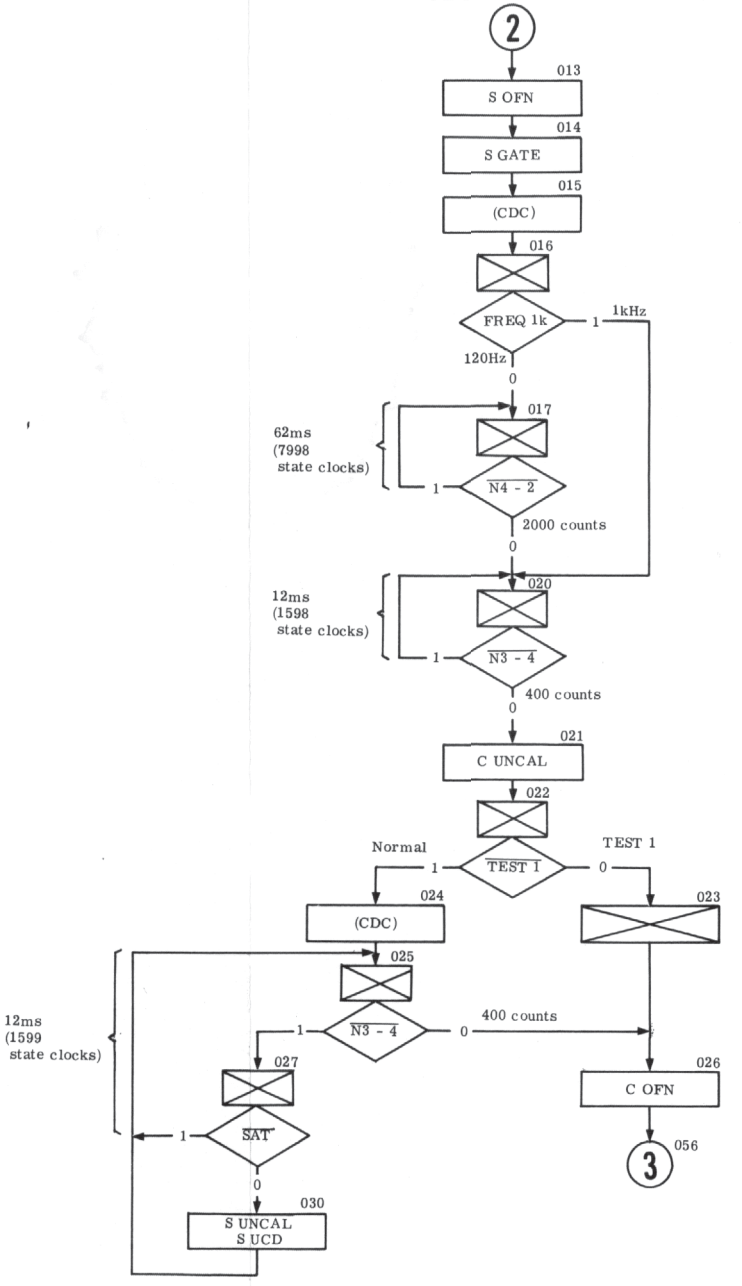


Figure 8-6. ASM Chart (Sheet 3 of 7).

AUTO OFFSET NULL



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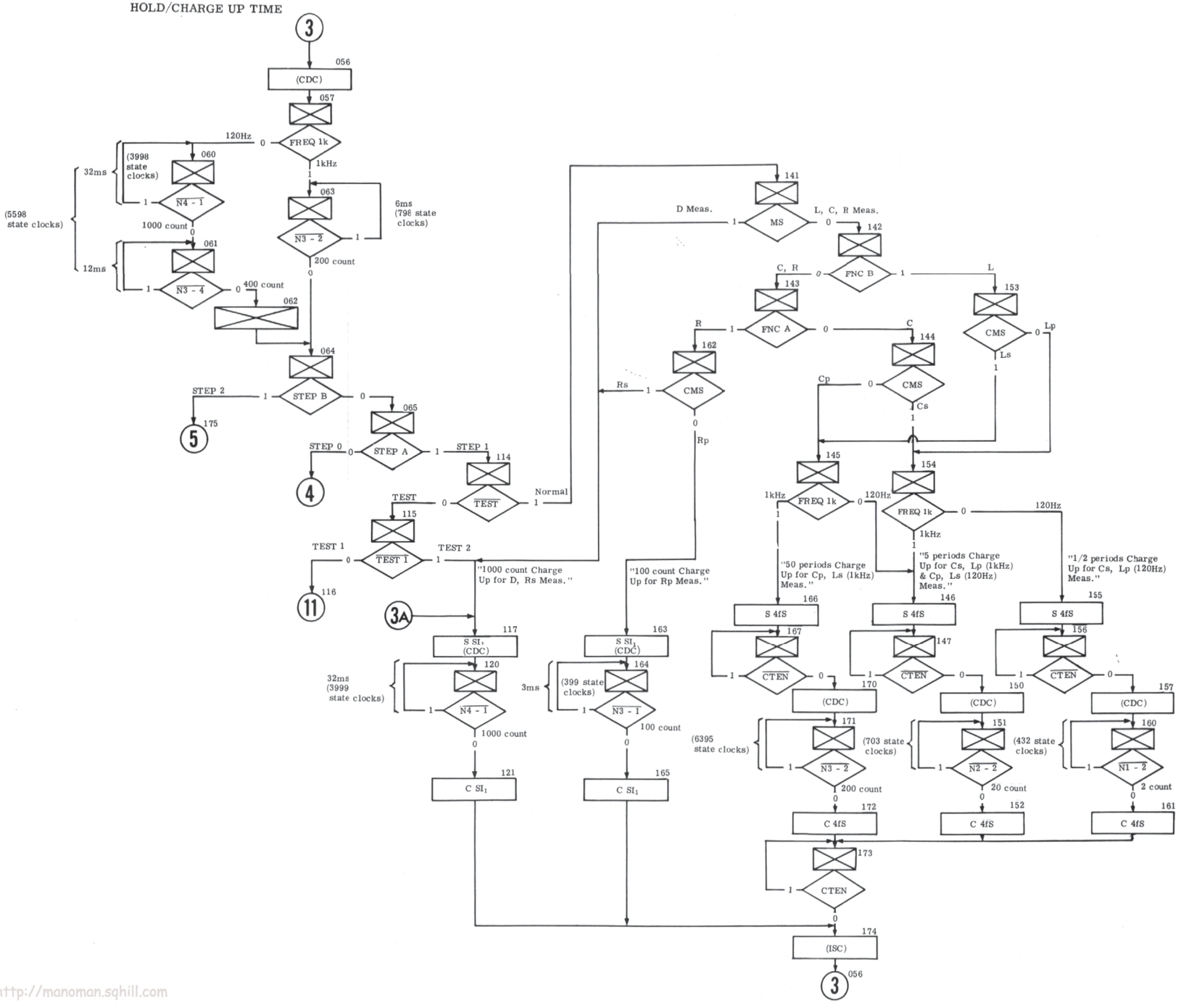
HOLD/CHARGE UP TIME



AUTO PHASE ADJUSTMENT

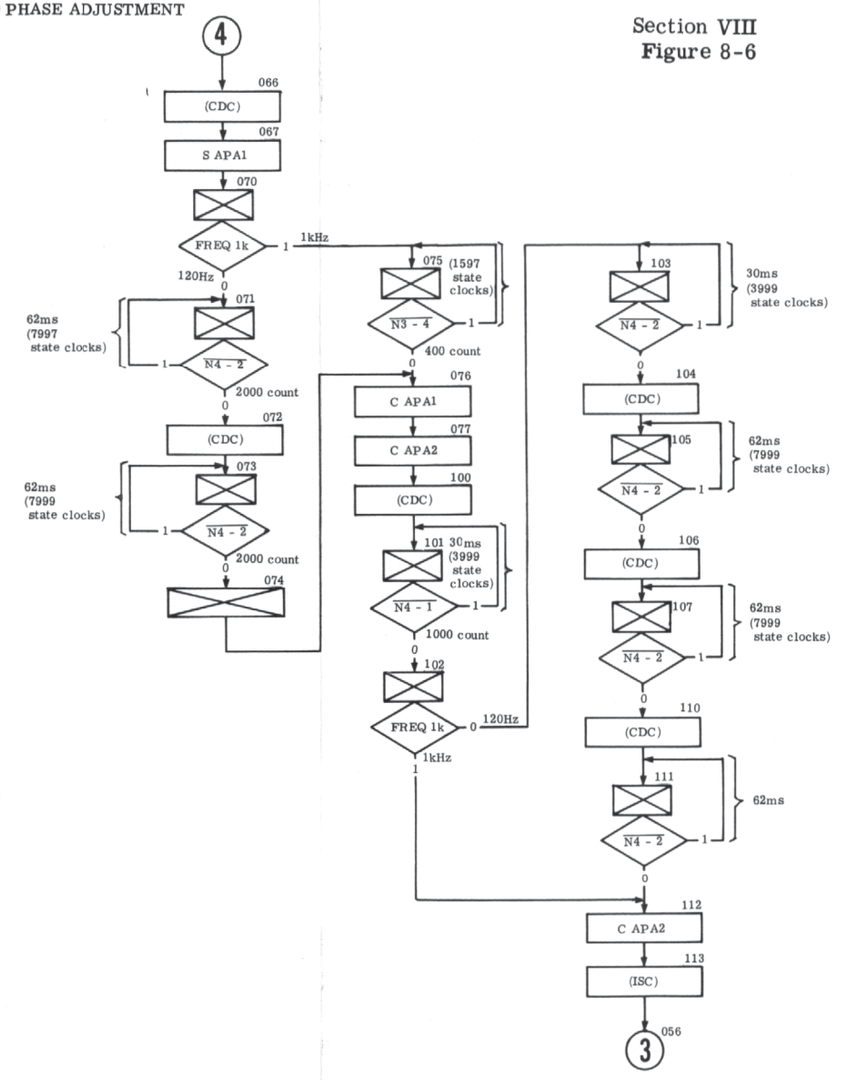


Figure 8-6. ASM Chart (Sheet 4 of 7).

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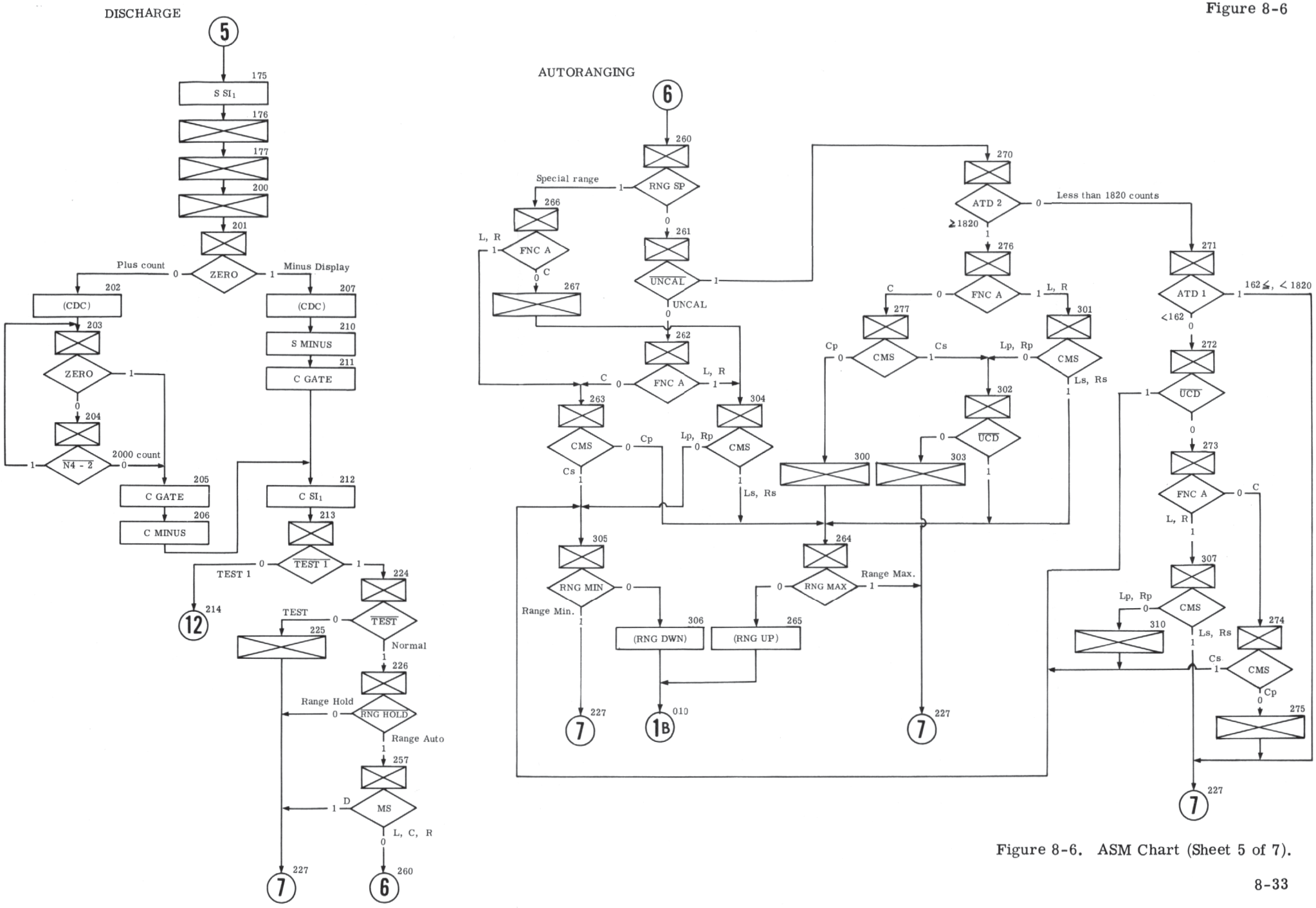

Figure 8-6. ASM Chart (Sheet 5 of 7).

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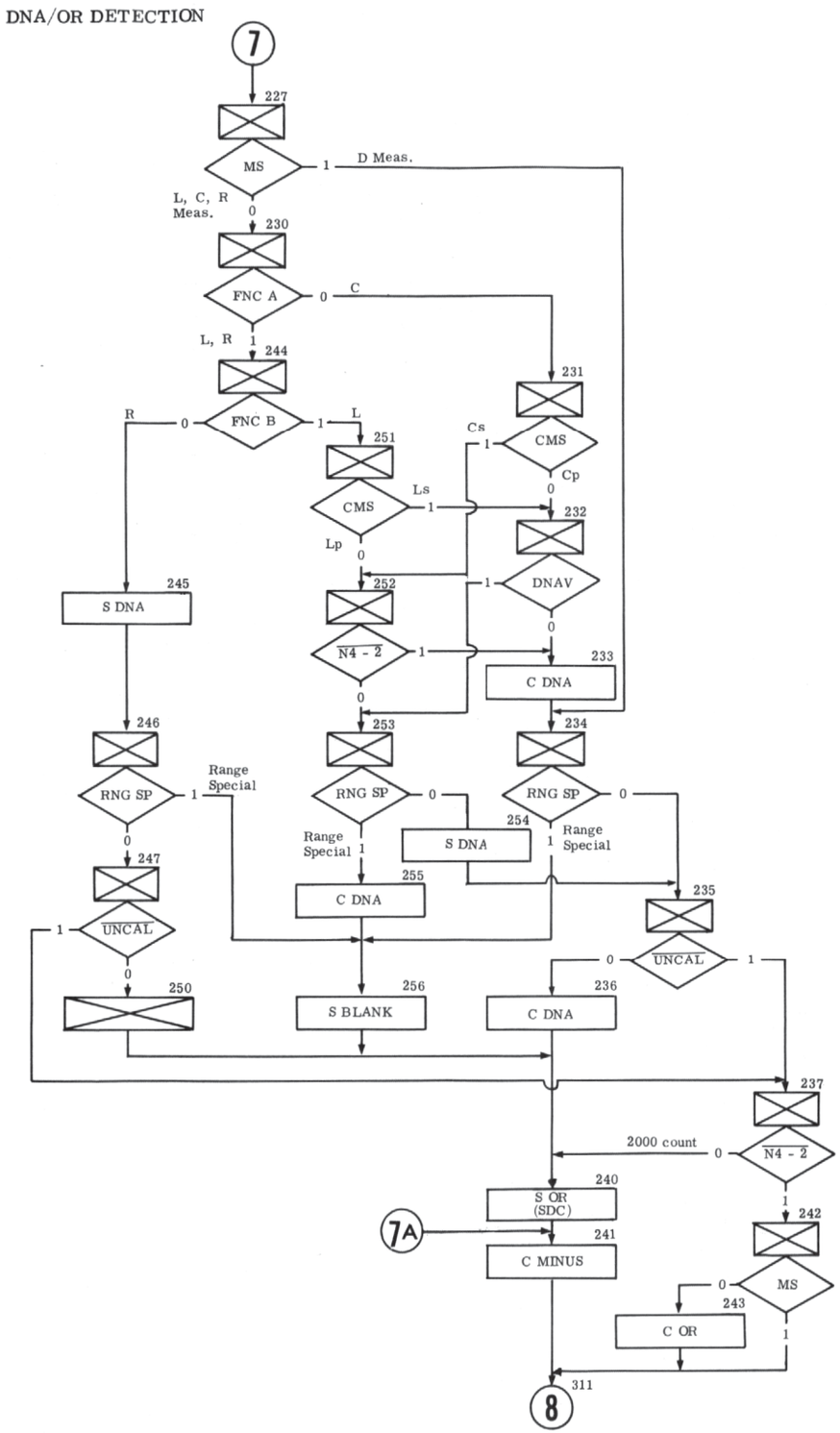

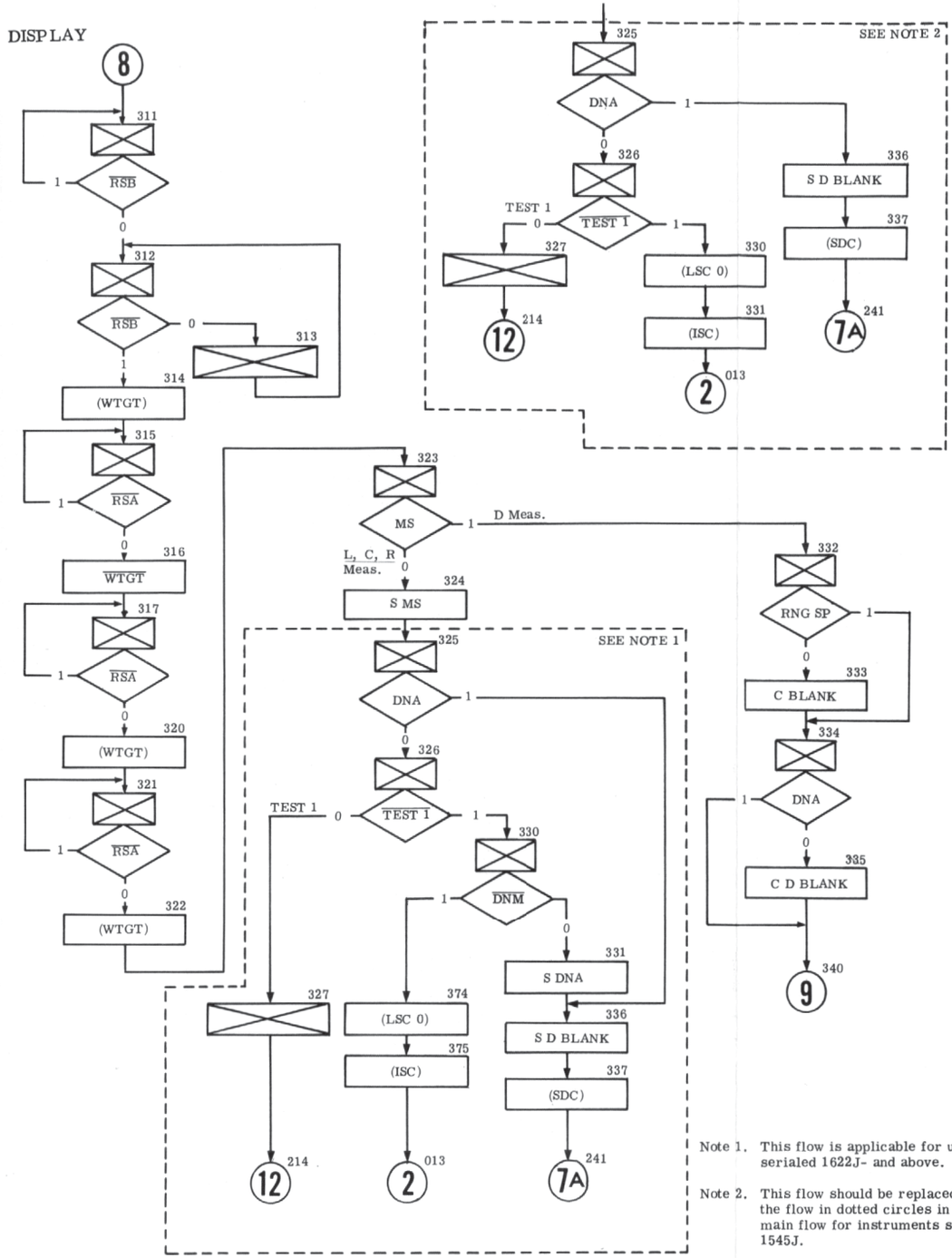

Note 1. This flow is applicable for units serialed 1622J- and above.

Note 2. This flow should be replaced with the flow in dotted circles in the main flow for instruments serialed 1545J.

Figure 8-6. ASM Chart (Sheet 6 of 7).

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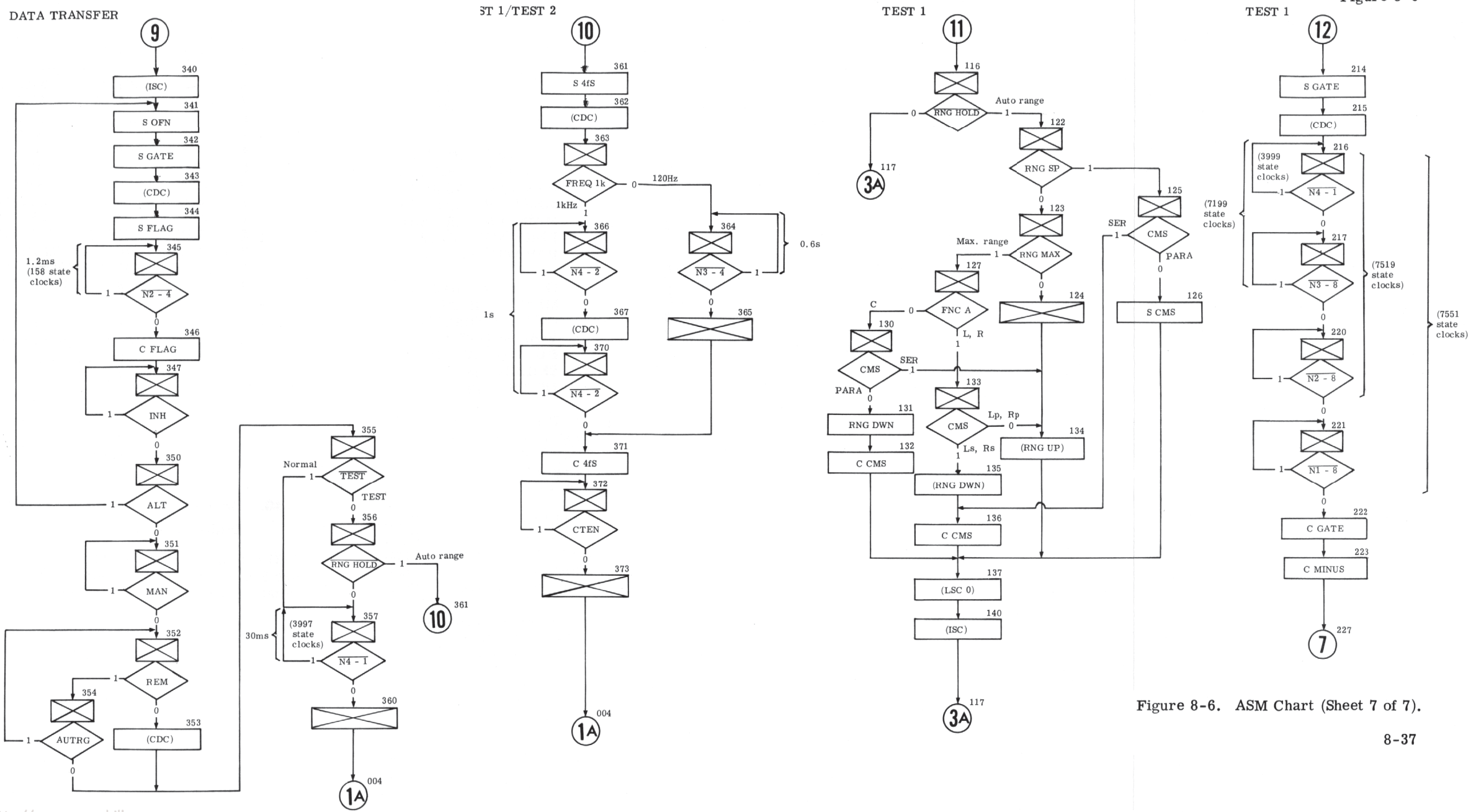

Figure 8-6. ASM Chart (Sheet 7 of 7).

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Misadjusted Control	Symptom
A4R87 (OFFSET)	When Cp TEST SIG LEVEL is set to 50mV, autoranging operation sometimes does not work well. DC level at A4TP3 varies on each range.
A5R31 (OFFSET-1)	Measurement accuracy when measuring as series equivalent is sometimes lower (due to improper dc level at A5TP3).
A5R40 (OFFSET-2)	Measurement error when measuring as parallel equivalent is sometimes excessive (due to improper dc level at A5TP3) especially when Cp TEST SIG LEVEL is set to 50mV.
A5R54 (OFFSET-3)	Measurement accuracy will decrease when offset voltage at A5TP3 is not 0 volts. This is usually more noticeable when Cp TEST SIG LEVEL is set to 50mV.
A5R84 (OFFSET-4)	D measurement error sometimes exceeds specifications (impossible to automatically adjust the detection phase of phase detector). This symptom is present when auto phase signal adjustment at A6TP3 exceeds 0 ±3 volts.
A6R65 (ZERO OFFSET)	Measurement errors for both LCR and D values have increased. The error is maximum for a 2000 count displays for either Cs, Lp and Rp measurements.
A6R67 (PHASE OFFSET)	D measurement has significant error (detection phase error).
A9R6 (+12V ADJ.)	DC supply voltages at A9TP4 (+12V), A9TP5 (-12V) and A9TP6 (+5V) have shifted to improper dc levels.

Figure 8-7. Front Panel Symptoms of Internal Control Misadjustment.

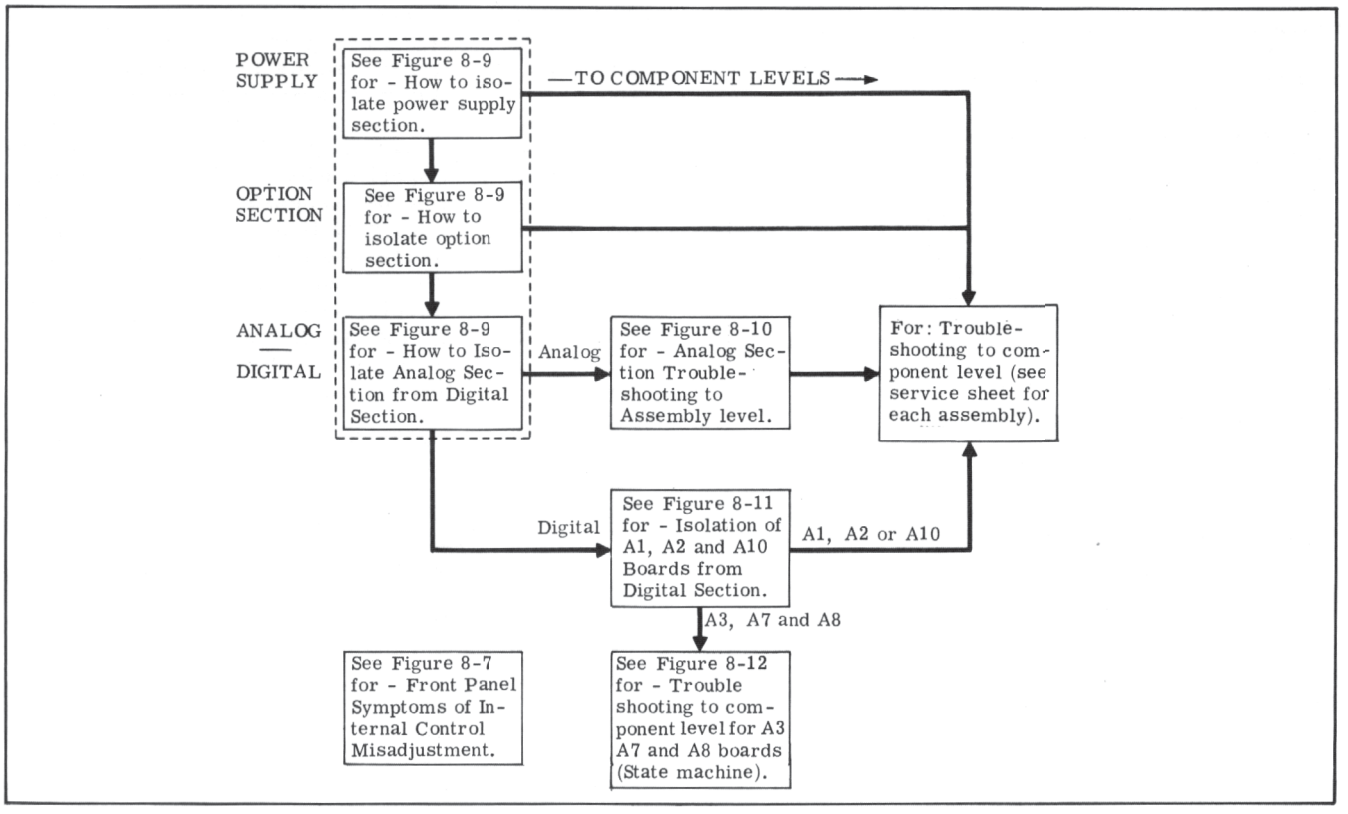

Figure 8-8. How to Use Troubleshooting Guides.

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The following is a complete list of control signals from the digital circuits (A3, A7 and A8 boards) to the analog section:

$\overline{TLL}$ $\overline{R100k}$, $\overline{R10k}$, $\overline{R1k}$, $\overline{R100}$, $\overline{R10}$	A3→A4
V TEST	A3→A5
PHASE 0, PHASE $\pi/2$, PHASE π, PHASE 3 /2	A3→A6
$\overline{SI}$	A7→A6
$\overline{OFN}$	A8→A5
OFNA	A8→(A5)→A6
$\overline{APA\ 1}$, $\overline{APA\ 2}$	A8→A6

Only three signals are fed from the analog section (A4, A5 and A6 boards) to the digital section. These are:

SAT	A5→A8
4f ZERO	A6→A7

8-32. Troubleshooting Analog Section to Assembly Level.

8-33. Follow the troubleshooting procedures in Figure 8-10 Analog Section Troubleshooting Guide to isolate an analog fault to a board assembly. Troubleshooting to component level is covered in the service sheet for each assembly.

8-34. Digital Section Troubleshooting.

8-35. Figures 8-11, 8-12 and Table 8-2 are troubleshooting guides for isolating A1, A2 and A10 boards from the digital section and provide help in locating the defective part in the state machine consisting of the A3, A7 and A8 board circuitry. Refer to the individual service sheet in this section for component level troubleshooting for the A1, A2, A3 or A10 boards. Final troubleshooting to the component level is covered in Figure 8-12 for the A3, A7 and A8 boards since these boards comprise the state machine in which it is difficult to isolate a defective part. Troubleshooting data for these boards is not provided in individual service sheets, so Figure 8-12 should be referred to when troubleshooting boards A3, A7 and A8 to the component level. Figure 8-6 also gives digital section troubleshooting using a logic state analyzer and the complete ASM chart. When using Figure 8-6, the Table 8-2 ASM chart check procedures will be helpful in troubleshooting.

8-36. Built-in Self Test Function.

8-37. The 4261A has a built-in self test function that checks whether the analog or digital section is working properly or not. To perform a self test, the slide switch mounted on the A8 board assembly (04261-77108) must be set to the proper position. Test operations are continuously repeated when EXT TRIGGER is set to INT; so it is usually better to set the TRIGGER selector to EXT and, for easy observation of front panel display, to advance the operation step-by-step with the MANUAL pushbutton. The following paragraphs explain self tests 1 and 2.

8-38. TEST 1 is a test position for the digital circuitry and almost all the digital circuitry can be checked merely by observing the front panel displays. TEST 1 can be done without regard to the analog signal section except that the sample rate time is shortened when the 4f signal is not inputted. Thus, if the TEST 1 results are false, the trouble is probably located in the digital circuitry. Conversely, if TEST 1 results are true, the electrical defect can usually (but not always) be isolated to the analog circuits. TEST 1 permits a constant 1888 counts to the counter and displays these counts for each measurement range with the decimal point inserted as appropriate. The range is stepped automatically. Thus, if the range does not step properly in this test, the trouble may be in the autoranging circuit. Table 8-3 shows the display sequence for TEST 1 and TEST 2 for each function with the condition at the UNKNOWN terminals. Figure 8-6 shows flow diagrams for both TEST 1 and TEST 2.

8-39. TEST 2 is designed to check the analog circuitry. If the digital section is functioning satisfactorily and analog circuitry is not defective, the front panel display will follow Table 8-3. TEST 2 integrates the reference signal for a period of 1000 counts and discharges the integrator with the same reference signal. The e_{ref} signal is phase-detected as an in-phase signal with respect to e_{ref} for LCR measurements and is phase-shifted by $\pi/2$ (= 90°) with respect to e_{ref} for D measurements. Therefore, the LCR display will be about 1000 counts and the D display will be about 0 counts (if the phase error of the detecting signal is very small). This operation is performed sequentially for each range and includes an Ls, Cp and Rs test. Unknown connectors should be shorted together to perform TEST 2 for L/R FUNCTIONS and open for a C FUNCTION test. If the results of TEST 1 are good and those of TEST 2 abnormal, the analog circuits are probably defective. LCR display must show 1000 counts ±5 counts and D display must show 0~5 counts. If the displays are out of these ranges, the 4261A may not satisfy its measurement specifications. Successful results of both tests does not necessarily mean that the 4261A meets all its specifications even though the counts are within the above limits. However, what it does mean is that, if any one range displays 1000 counts on LCR display and 0 counts on D display, respectively, then the A5 circuitry (after signal selector), A6 phase detector, integrator and zero detector are probably normal.

8-40. If TEST 1 is normal and TEST 2 is attempted on normal ranges when the ZERO signal from the analog section remains continuously at LOW level, the display will always read 1999 counts. If ranging is abnormal under these conditions, the display will be blank. Conversely, if the conditions are the same as above except that the ZERO signal remains continuously at HIGH level, then the display results for TEST 2 will be as shown in the table which follows:

FUNCTION	Unknown	Display
L/R	Open	1999 counts
L/R	Short	-000
C	Open	-000
C	Short	1999

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If ranging is abnormal under these conditions, the display will be blank.

Note

When LCR display shows -000 counts, D display is blanked.

Even if a 4f signal is not received by the digital section, both TEST 1 and 2 will appear normal except that the sample rate time will decrease.

8-41. RECOMENDED TEST EQUIPMENT.

8-42. Since a logic state analyzer is usually used when monitoring the state codes of the state machine for troubleshooting the logic circuitry, Hewlett-Packard provides a service cable which is helpful in connecting 4261A circuits to the logic state analyzer input cables. The HP part number for this cable is 04261-65001. Figure 8-14 is an illustration of the cable connections to HP logic state analyzer input cables. Extender Board P/N 5060-4017, is useful for troubleshooting, and is available from Hewlett-Packard. The extender is listed in Table 1-4.

8-43. Table 1-5 lists all test equipment used for the troubleshooting outlined in this section. Hewlett-Packard often prepares a board kit or a spare parts kit to assist in troubleshooting and to reduce repair time. Contact your nearest HP office for information.

8-44. REPAIR.

8-45. Q1 Removal.

a. Remove Q1 transistor cover (rear panel).

b. Remove Q1 from rear panel by removing its two mounting screws.

c. Install new Q1.

d. Replace cover.

8-46. Removal of Q2 or Q3.

a. Remove top cover from instrument.

b. Remove the two transistor mounting screws.

c. Lift out transistor.

d. Install new transistor.

8-47. Removal of CR1 thru CR3.

a. Remove top and bottom covers from instrument.

Note

If any option is installed in instrument, remove flat cable from rear connector assembly.

b. Unsolder diode wire lead.

c. Remove 3/8" nut with hex driver.

d. Install new diode.

e. Solder lead to diode and mount diode on deck.

8-48. Removal of A1 Switch Board.

Note

Removal procedure for A2 Display board is printed on the angle blacket of A2 board. Remove top cover to locate and read these instructions.

a. Remove top cover from the instrument.

b. Remove both adhesive side trim strips from front frame.

c. Remove the four screws from side frames.

d. Pull front panel slightly forward.

Note

Do not use excessive force or wire connections to unknown terminals may break.

e. Remove MANUAL switch mounting nut from front panel. Use 5/16 inch hex driver.

f. Remove the A3 board by disconnecting the three flat cables.

g. Remove the three screws which mount the A1 switch board to the front panel. A screw driver should be inserted in the opening between A3 board and front frame.

h. Remove A1 board flat cable connector from A10 mother board.

i. Push A1 board to rear and lift out.

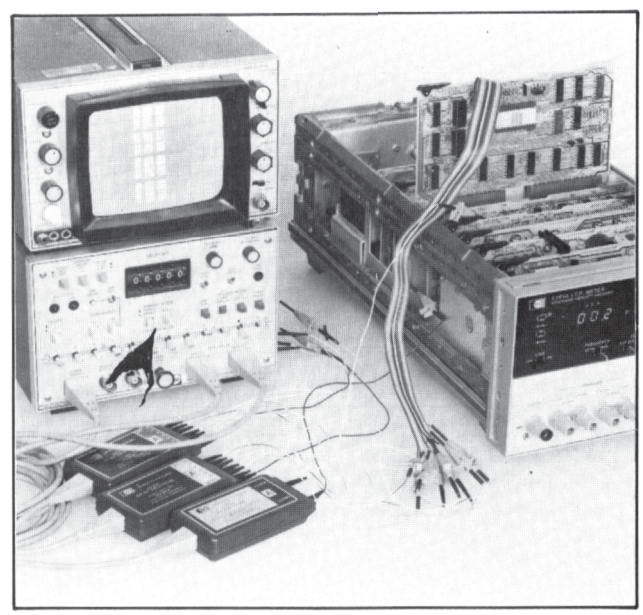

Figure 8-13. Service Cable Connections.

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8-49. PRODUCT SAFETY CHECKS.

WARNING

WHENEVER IT APPEARS LIKELY THAT SAFETY PROTECTIVE PROVISIONS HAVE BEEN IMPAIRED, THE APPARATUS SHALL BE MADE INOPERATIVE AND BE SECURED AGAINST ANY UNINTENDED OPERATION. THE PROTECTION IS LIKELY TO BE COMPROMISED IF, FOR EXAMPLE:

-- THE APPARATUS SHOWS VISIBLE DAMAGE.
-- THE INSTRUMENT FAILS TO PERFORM THE INTENDED MEASUREMENT.
-- THE UNIT HAS UNDERGONE PROLONGED STORAGE UNDER UNFAVORABLE CONDITIONS.
-- THE INSTRUMENT HAS SUFFERED SEVERE TRANSPORT STRESS.

8-50. The following five checks are recommended to verify the product safety of the 4261A LCR Meter (these checks may also be done to check for product safety after troubleshooting and repair). When such checks are needed, perform the following:

1. Visually inspect interior of instrument for any signs of abnormal internally generated heat, such as discolored printed circuit boards or components, damaged insulation, or evidence of arcing. Determine and remedy cause of any such condition.

2. Using a suitable ohmmeter, check resistance from instrument enclosure to ground pin on power cord plug. The reading must be less than 0.5 ohm. Flex the power cord while making this measurement to determine whether intermittent discontinuities exist.

3. Check GUARD terminal on front panel using procedure (2).

4. Disconnect instrument from power source. Turn power switch to on. Check resistance from instrument enclosure to line and neutral (tied together). The minimum acceptable resistance is two megohms. Replace any component which fails or causes a failure.

5. Check line fuse to verify that a correctly rated fuse is installed.

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DC Power Supply Section Check.

Are the following dc voltages correct on A9 Board ?
+11.95 thru +12.05V (A9TP4)
-12.15 thru -11.85V (A9TP5)
+ 4.85 thru + 5.15V (A9TP6)

YES → 1. Perform self-test 1 (Digital Circuits Test) for L, C and R FUNCTIONS. Refer to Table 8-3
2. Are all tests satisfactory ? (NOTE: see below)

NO → Go to Figure 8-11

YES → 1. Perform self test 2 (Analog Circuits Test) for L, C and R. In C FUNCTION, perform at Cp TEST SIG LEVELS of both 50mV and 1V. Refer to Table 8-3
2. Are all tests satisfactory ?

YES → 1. Perform self test 1.
2. Do the following digital signals exist ?

Signal	Location
$\overline{R10}$	A3 (ML)
$\overline{R100}$	A3 (NL)
$\overline{R1k}$	A3 (PL)
$\overline{R10k}$	A3 (RL)
$\overline{R100k}$	A3 (SL)

NO → Go to Figure 8-11.

YES → Go to Figure 8-10.

NO → 1. Pull out A4, A5 and A6 printed circuit boards from unit.
2. In C FUNCTION, perform self test 1 at a Cp TEST SIG LEVEL of 50mV.
3. Do the following digital signals exist (it is sufficient to verify that high and low TTL levels exist at each pin) ?

Signal	Location
PHASE Ø	A3 (4L)
PHASE $\pi/2$	A3 (DL)
PHASE π	A3 (5L)
$\overline{TLL}$	A3 (3R)
$\overline{SI}$	A7 (3L)
$\overline{OFN}$	A8 (3R)
$\overline{APA\ 1}$	A8 (5R)
$\overline{APA\ 2}$	A8 (AR)

NO → A1, A3, A7, A8 or A10 printed circuit board may be faulty. Go to Figure 8-11.

YES → 1. Isolate defective board by inserting printed circuit boards one by one.
2. Go to service sheet for defective board.

NO → Go to service sheet No. 9.

NOTE

If display is abnormal, A2 Display Board can be checked by this procedure (lamp, 7-segment display, etc.). Note which display is abnormal for use in Figure 8-11.

OPTION BOARD ISOLATION

The optional board can be easily isolated from other 4261A circuitry. First remove the option 001 board (A21 P/N: 04261-77021) or option 002 board (A22, P/N: 04261-77022) from the 4261A. If the trouble symptom previously recognized disappears, the trouble may be in the option board, rear connector, or external device. If not, the option board is normal.

To isolate a trouble in option 003, remove the flat cable which combines the rear connector with the A10 mother board from the A10 board. If the 4261A functions properly in local control, the trouble may be located in the option 003 cable, connector or external device. If not, the option 003 is not defective.

Figure 8-9. How to Isolate Analog Section from Digital Section.

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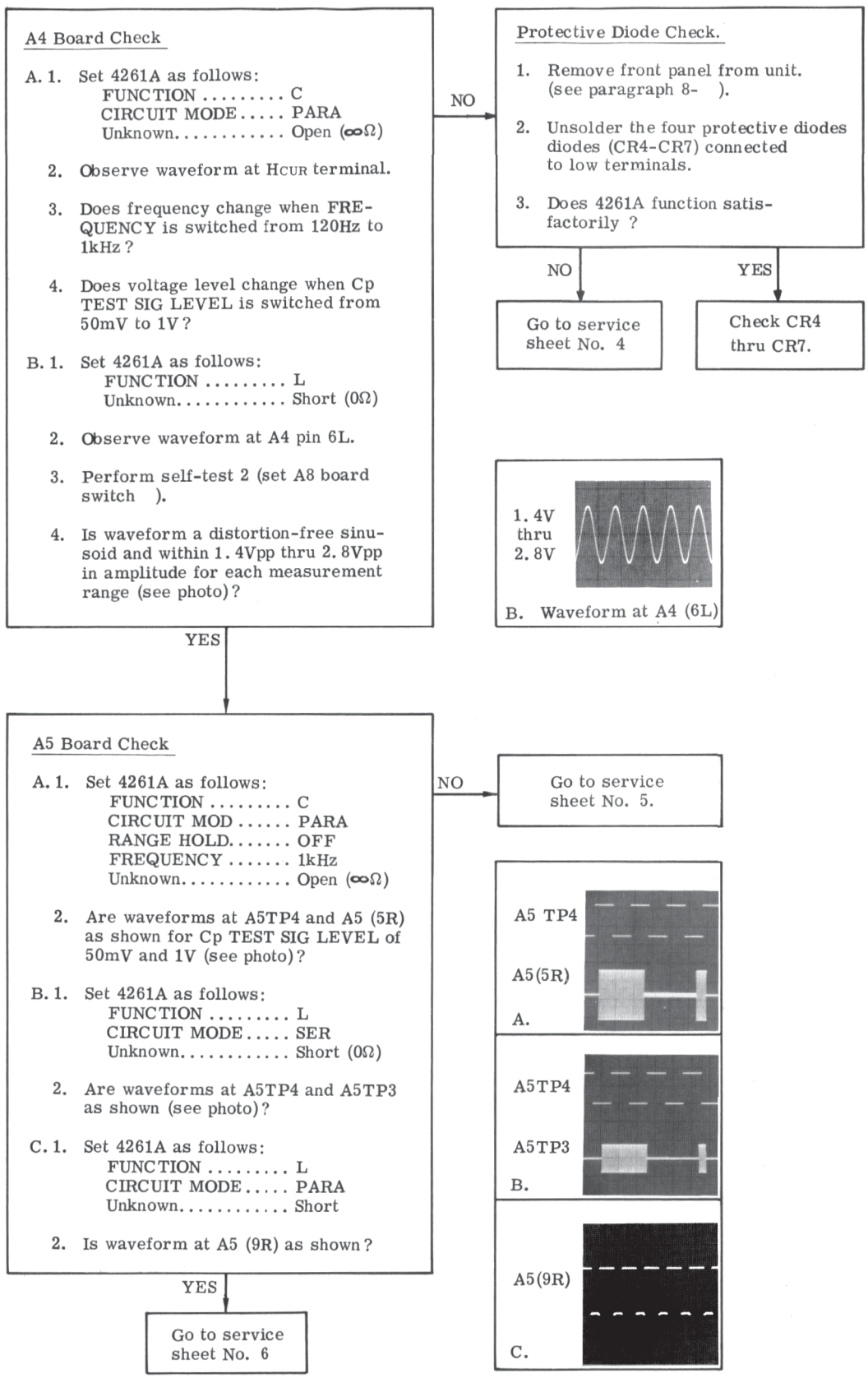

Figure 8-10. Analog Section Troubleshooting to Assembly Level.

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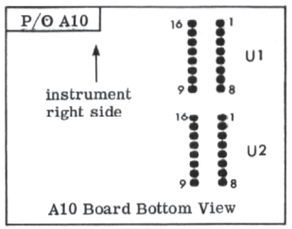
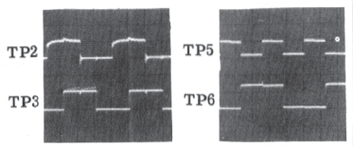
1. Remove instrument bottom cover.
2. Check that the activity at A10U1 and U2 pins is as follows (see figure below for pin locations):

Pin	Action for level change
U1 (4)	Cp TEST SIG LEVEL: 50mV, 1V
U1 (7)	FREQUENCY: 120Hz, 1kHz
U1 (12)	RANGE HOLD: OFF, ON
U2 (4), U2 (7)	CIRCUIT MODE: PARA, SER
U2 (9), U2 (12)	FUNCTION: L, C, R



YES → 1. Observe waveforms at A7TP2, 3, 5 and 6.
2. Are they the same as in figure below?



NO → Does 2.5465MHz clock signal exist at A7TP1?

NO → Check A7U1, Y1, etc.

YES → Check A7U6-U8, U14, U15, etc.

YES → 1. Disconnect A8 board from unit.
2. Short A3TP3 to instrument chassis.
3. Do both LCR and D displays display -1888 count?

NO → Under conditions given in above box:
1. Do Anode signals (ANOD 1 thru ANOD 4) exist at A3U16 pins 6 and 9, and A3U17 pins 6 and 9?
2. Are output pins 9 thru 15 for A3U1 and U2 at low level (≈0V)?

NO → Check A3 Anode Driver circuits (A3U14-U17, Q1-Q4) or A3U1-U2.

YES → A2 Board Check

Check that circuit mode indicators, unit lamps, and decimal points all light properly. Use the following procedure:

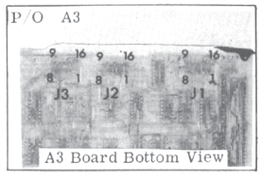
A. Perform self test 1 for L, C and R functions.

B. Disconnect A8 board from unit and turn LINE on.

C. Operate FUNCTION and CIRCUIT MODE switches to light each circuit mode indicator lamp in normal operation.

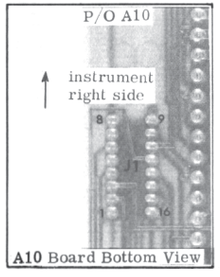
D. Check lamps that do not light by grounding pins A3J1 through J3. (see figure below).

Indicator lit		Pin No. Grounded
Trigger lamp		A3 J1- 5
CIRCUIT MODE:	Ls	J1 - 13
	Lp	J1 - 14
	Cs	J1 - 15
	Cp	J1 - 16
Unit lamps:	Ω	J2 - 3
	k	J2 - 4
	n	J2 - 5
	p	J2 - 6
	F	J2 - 8
	m	J2 - 9
	μ	J2 - 10
	H	J2 - 11
	M	J2 - 13
Decimal Point: LCR		J1 - 7, 8
	D	J3 - 15
"OUT OF RANGE"		J3 - 13



YES → NO → Replace defective LED lamp on A2 Board.

NO → 1. Remove A10U1 and U2 from A10 board.
2. Remove bottom cover from unit.
3. Check that dc level changes occurs as follows when front panel controls are operated (monitor at each pin of dual-in-line connector located behind instruction card.): See figure below for pin locations.



Pin No.	Panel Control	Level Change
1, 15	FUNCTION	0V, 5V
4	DC BIAS	1.5V, 2.2V, 6V, 0V
5	Cp TEST SIG LEVEL	0V, 5V
6, 7	CIRCUIT MODE	0V, 5V
8	MANUAL(TRIGGER:EXT)	0V, 5V
9	RANGE HOLD	0V, 5V
10	TRIGGER	0V, 5V
13	DC BIAS: 1.5V	1.5V
14	DC BIAS: 2.2V	2.2V
16	FREQUENCY	0V, 5V

YES → Go to service sheet No. 10.

NO → Go to service sheet No. 1.

Figure 8-11. Isolation of A1, A2 and A10 Boards in Digital Section.

1. Remove A8 board from unit. Set 4261A FREQUENCY to 1kHz.
2. Does a signal exist at A7U9 pin (3)?

YES → 1. Remove A6 and A8 boards from unit.
2. Observe waveform at A7U5 pin (9). Does signal have both 0V and +5V levels (digital signal)?

NO → Check A7U5, etc.

YES → 1. Remove A8 board from unit.
2. Does digital signal output exist at A7 pins (6R), (7R), (8R) and (9R)?
3. Does dc level at A7U21 pin 4 change from low to high (+5V), and does dc levels at A7U21 pins 9 and 13 change from high to low (0V) when A7 pin (15L) is grounded?

NO → If 2 is faulty, check A7U11, 12.
If 3 is faulty, check A7U20, U21, U17.

YES → 1. Remove A8 board from unit.
2. Set 4261A FREQUENCY to 1kHz.
3. Does D Display show the following display when A3TP4 and A3 pin (CL) are grounded?

-1888

4. Does LCR Display show the above display when A3 pins (CL) and (KL) are grounded?

NO → Check A3U8, U9 U13, U17.

YES → Go to Figure 8-12.

NO → Does a signal exist at A7U9 pin (11)?

NO → Check A7U9, U16, U15, etc.

YES → Does a signal exist at A7U17 pin (3)?

NO → Check A7U17

YES → Check A7U2-U4, U9, etc.

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This troubleshooting can be done with a logic probe (HP 10525T, for example) as well as with an oscilloscope.

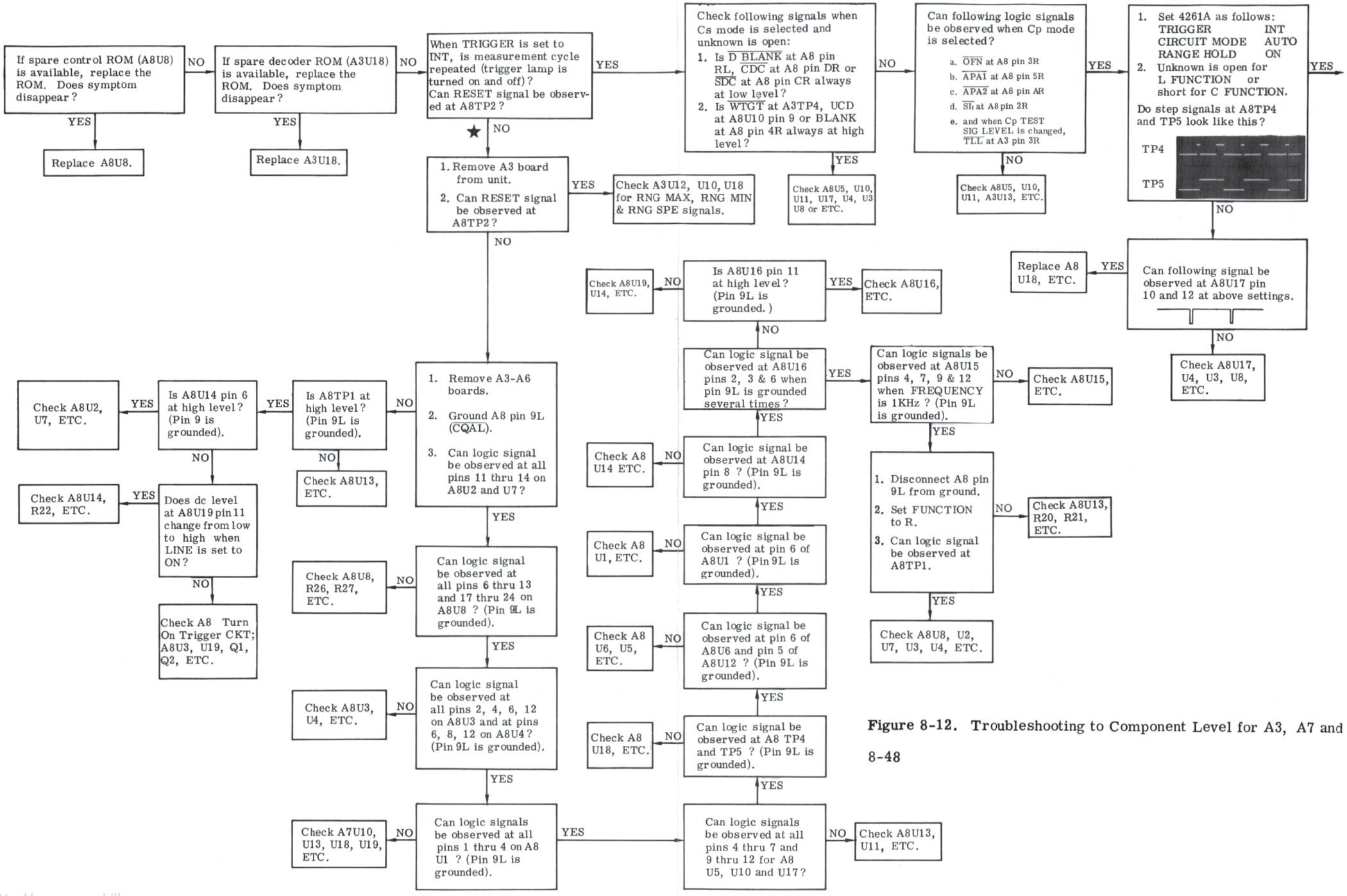

Figure 8-12. Troubleshooting to Component Level for A3, A7 and A8 Boards.

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1. Set 4261A as follows:
   TRIGGER-------INT
   CIRCUIT MODE-AUTO
   RANGE HOLD---OFF
2. Can level changes be observed at A8U16 pins 2, 3, & 6 when unknown is changed from open to short or the reverse for each FUNCTION (L, C and R)?

YES → 1. Set 4261A as follows: TRIGGER-------INT CIRCUIT MODE-AUTO RANGE HOLD---OFF
2. Do all unit, circuit mode and decimal point displays light properly when operating unit as in step 2 in box to left?
3. Can level changes be observed at A3U11 pins 8, 10, 15 & 16 and A3U12 pins 1, 10 & 15 when operating unit as in step 2 in box to left?

YES → Can same logic signal be observed at A8TP3 and A8U15 pin 9, A8TP4 and A8U15 pin 4, A8TP5 and A8U15 pin 7, respectively when LSCØ signal is at high level?

YES → Can logic signal be observed at A3U10 pins 4, 6, 8 & 10 when 4261A is operated as follows?

FUNCTION		C		L	
UNKNOWN		Short		Open	
CKT. MODE		PARA	SER	PARA	SER
A3U10 Pin No.	4	High/Low	High/Low	High/Low	High/Low
	6	Low	High/Low	High/Low	Low
	8	High/Low	Low	Low	High/Low
	10	High/Low	High/Low	Low	High/Low

YES → 1. Turn LINE to OFF.
2. Turn LINE to ON. Trouble sympton will appear on the unit.
3. Push MANUAL trigger button. Does the sympton disappear by this operation?

YES → Check A8 Turn On Trigger Circuit; A8U19, Q1, Q2, U3, ETC.

NO → Check functioning of following signals. If abnormal, check the circuit route. Follow instructions below: If all signals are normal, perform troubleshooting procedure beginning at starred (★) point earlier in this tree.

- "4fS" → Logic signal should be at A8U5 pin 11 for C/L measurement. If not, check A8, U5, U4, U3, U8, ETC.
- "OR" → If "OUT OF RANGE" never lights or always lights, set FUNCTION to C, CIRCUIT MODE to SER and unknown to open. Can level change be observed at A8U10 pin 12?
  - YES → Check A8U7 ETC.
  - NO → Check A8U10, U4, U3, U8, ETC
- "TRGL" → If trigger lamp never lights or always lights, check that logic signal exist at A8U13 pin 9. If yes, check A8U11, R15, ETC. If no, check A8U13.
- "FLAG" → FLAG signal should be at A8 U10 pin 11 when TRIGGER is set to INT. If not, check A8 U10, U4, U3, U8, ETC.

NO → Check A3U13, U10, U18, ETC.

NO → Check A8U15, ETC.

NO → 1. Set 4261A as follows: TRIGGER-------INT CIRCUIT MODE-AUTO RANGE HOLD---OFF
2. Can following signal be observed at A8U17 pin 7 when unknown is changed from open to short for C FUNCTION and from short to open for L and R FUNCTIONS?
3. Can following signal be observed at A8U17 pin 6 when unknown is changed from short to open for C FUNCTION, and from open to short for L and R FUNCTIONS?

YES → Check A8U16, U19, U14, ETC

NO → Check A8U17, U4, U3, U8, ETC.

NO → Can LSCO signal be observed at A3U4 pin 4 and A3TP1?

NO → Check A3U14, ETC.

YES → Can logic signal be observed at A3U11 pin 6 when unknown is changed from open to short or the reverse?

NO → Check A8U15, A3U18, ETC.

YES → Can level change be observed at A8 pin 6R when CIRCUIT MODE is changed from PARA to SER of the reverse?

NO → Check A8 U10, ETC.

YES →
1. Check corresponding circuits in A3U3-U7, A3U10, R1, R4-8 for lamp showing abnormal display.
2. Check corresponding circuits in A3U10-U12, A3U18 showing abnormal signal (or no level change) at A3U12 pins 1, 10 or 15.

Figure 8-12. Troubleshooting to Component Level for A3, A7 and A8 Boards.

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Table 8-3. Self Test Display Sequences (Sheet 1 of 2).

Note

1. It is easier to read display sequences with TRIGGER set to EXT and operating MANUAL button.
2. RANGE HOLD should be set to OFF for all display sequences.
3. TEST 1 is not affected by conditions at UNKNOWN terminals (shorted, DUT connected or otherwise).
4. In a TEST 2 operation, when Unknown terminals are open in L/R FUNCTION or shorted in FUNCTION C, both 4261A displays will show 1999 counts and OUT OF RANGE lamp will be lit (except when sequencing produces an OUT OF RANGE condition --- here, display will be blanked).

TEST 1, FUNCTION: L

	FREQUENCY: 120Hz				FREQUENCY: 1kHz			
	L Display	Unit		D Display	L Display	Unit		D Display
Ls	1888	μH		1.888	188.8	μH		1.888
	18.88	mH		1.888	1888	μH		1.888
	188.8	mH		1.888	18.88	mH		1.888
	1888	mH		1.888	188.8	mH		1.888
	18.88	H		1.888	1888	mH		1.888
Lp	1888	mH		1.888	188.8	mH		1.888
	18.88	H		1.888	1888	mH		1.888
	188.8	H		1.888	18.88	H		1.888
	1888	H		1.888	188.8	H		1.888
	1888	H		1.888	188.8	H		1.888
	(Blank)	μH	OUT OF RANGE	(Blank) .	(Blank) .	μH	OUT OF RANGE	(Blank) .

TEST 1, FUNCTION: C

	FREQUENCY: 120Hz				FREQUENCY: 1kHz			
	C Display	Unit		D Display	C Display	Unit		D Display
Cp	1888	pF		1.888	188.8	pF		1.888
	18.88	nF		1.888	1888	pF		1.888
	188.8	nF		1.888	18.88	nF		1.888
	1888	nF		1.888	188.8	nF		1.888
	18.88	μF		1.888	1888	nF		1.888
Cs	1888	nF		1.888	188.8	nF		1.888
	18.88	μF		1.888	1888	nF		1.888
	188.8	μF		1.888	18.88	μF		1.888
	1888	μF		1.888	188.8	μF		1.888
	18.88	mF		1.888	1888	μF		1.888
	(Blank)	pF	OUT OF RANGE	(Blank) .	(Blank) .	pF	OUT OF RANGE	(Blank) .

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Table 8-3. Self Test Display Sequences (Sheet 2 of 2).

TEST 1. FUNCTION: R

	FREQUENCY: 120/1kHz		
	R Display	Unit	
Rs	1888	mΩ	
	18.88	Ω	
	188.8	Ω	
	1888	Ω	
	18.88	kΩ	
Rp	1888	Ω	
	18.88	kΩ	
	188.8	kΩ	
	1888	kΩ	
	18.88	MΩ	
	(Blank)	mΩ	OUT OF RANGE

TEST 2. FUNCTION: R, Unknown: Short

	FREQUENCY: 120/1kHz		
	R Display	Unit	
Rs	1000 ±5	mΩ	
	10.00 ±5	Ω	
	100.0 ±5	Ω	
	1000 ±5	Ω	
	10.00 ±5	kΩ	
	(Blank)	kΩ	OUT OF RANGE
	(Blank)	kΩ	OUT OF RANGE
	(Blank)	MΩ	OUT OF RANGE

TEST 2. FUNCTION: L, Unknown: Short

	FREQUENCY: 120Hz				FREQUENCY: 1kHz			
	L Display	Unit		D Display	L Display	Unit		D Display
Ls	1000 ±5	μH		.000 $^{+5}_{-0}$	100.0 ±5	μH		.000 $^{+5}_{-0}$
	10.00 ±5	mH		.000 $^{+5}_{-0}$	1000 ±5	μH		.000 $^{+5}_{-0}$
	100.0 ±5	mH		.000 $^{+5}_{-0}$	10.00 ±5	mH		.000 $^{+5}_{-0}$
	1000 ±5	mH		.000 $^{+5}_{-0}$	100.0 ±5	mH		.000 $^{+5}_{-0}$
	10.00 ±5	H		.000 $^{+5}_{-0}$	1000 ±5	mH		.000 $^{+5}_{-0}$
	(Blank)	H	OUT OF RANGE	(Blank)	(Blank)	H	OUT OF RANGE	(Blank)
	(Blank)	H	OUT OF RANGE	(Blank)	(Blank)	H	OUT OF RANGE	(Blank)
	(Blank)	H	OUT OF RANGE	(Blank)	(Blank)	H	OUT OF RANGE	(Blank)

TEST 2. FUNCTION: C, Unknown: Open

	FREQUENCY: 120Hz				FREQUENCY: 1kHz			
	C Display	Unit		D Display	C Display	Unit		D Display
Cp	1000 ±5	pF		.000 $^{+5}_{-0}$	100.0 ±5	pF		.000 $^{+5}_{-0}$
	10.00 ±5	nF		.000 $^{+5}_{-0}$	1000 ±5	pF		.000 $^{+5}_{-0}$
	100.0 ±5	nF		.000 $^{+5}_{-0}$	10.00 ±5	nF		.000 $^{+5}_{-0}$
	1000 ±5	nF		.000 $^{+5}_{-0}$	100.0 ±5	nF		.000 $^{+5}_{-0}$
	10.00 ±5	μF		.000 $^{+5}_{-0}$	1000 ±5	nF		.000 $^{+5}_{-0}$
	(Blank)	μF	OUT OF RANGE	(Blank)	(Blank)	μF	OUT OF RANGE	(Blank)
	(Blank)	μF	OUT OF RANGE	(Blank)	(Blank)	μF	OUT OF RANGE	(Blank)
	(Blank)	mF	OUT OF RANGE	(Blank)	(Blank)	μF	OUT OF RANGE	(Blank)

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Inductance is in microhenries, resistance is in ohms and capacitance is in microfarads unless otherwise noted.

P/O — Part of

Screwdriver adjustment.

Circuit assembly borderline.

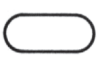
* — Asterisk denotes a factory selected value. Value shown is typical. Part may be omitted.

Heavy line indicates main signal path.

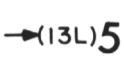
Heavy dashed line indicates main feedback path.

Wiper moves towards CW with clockwise rotation of control (as viewed from shaft or knob).

Numbered test point. Measurement aid provided.



Encloses wire color code. Code used is the same as the resistor color code (e.g., (947) denotes white/yellow/violet).



Indicates an output from a schematic that goes to an input identified as 13L (board plug pin number) on Service Sheet 5.

Indicates an input to a schematic that comes from an output identified as 15R (board plug pin number) on Service Sheet 9.

Indicates direct conducting connection to the earth.

Indicates conducting connection to a chassis or frame.

Indicates circuit common connections.

Non plug-in connection information. Soldered connection.

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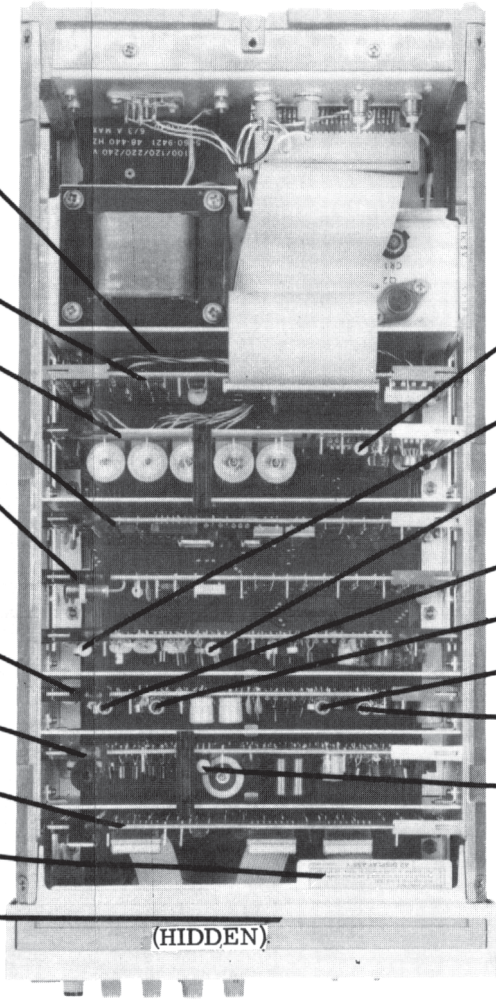
Figure 8-14. Schematic Diagram Notes.



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* Options.

Figure 8-15. Assembly and Adjustment Locations. (Top Internal View)

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CIRCUIT DESCRIPTION

The A1 Switch Board Assembly consists of seven slide switches and one normally open pushbutton switch which control various measurement functions of the 4261A. The control signals set by the switches are transferred to A10 Mother board assembly through a 16-line flat cable (A1W1). Local control by the A1 board assembly is only disabled when 4261A Option 003 or 101 are installed and an external device controls the 4261A. The control signals transmitted to A10 Mother board have the electrical conditions shown in table. An external encode (= $\overline{EXE}$) signal is generated when either FREQUENCY, Cp TEST SIG LEVEL, FUNCTION, CIRCUIT MODE or the RANGE HOLD control is changed to any other setting or when MANUAL pushbutton is depressed and released. An $\overline{EXE}$ signal resets all the 4261A circuits and starts the measurement. The GND line is connected to instrument chassis through the A10 Mother board.

TROUBLESHOOTING INFORMATION

A1 Switch Removal Procedure is given in paragraph 8-48.

A1 Switch Check.

Check voltages at A1W1 connector pins (component side of A1) with oscilloscope to verify they follow above table when controls are set to the various positions. The trouble could be, for example, the wearing away of switch board pattern or the loss spring tension in switch.

Table A. Front Panel Control Signals.

Signal and Connector Pin No.		FREQUENCY	
		120Hz	1kHz
$\overline{FREQ\ 1kHz}$ (= $\overline{FREQ}$)	16	High	Low

Signal and Connector Pin No.		Cp TEST SIG LEVEL	
		50mV	1V
Test Level Low (= TLL)	5	High	Low

Signal and Connector Pin No.		DC BIAS				
		EXT	OFF	1.5V	2.2V	6V
REF Voltage	2	0V	0V	1.5V	2.2V	6V
BIAS	3	Voltage applied to EXT BIAS input at rear panel.	0V	1.5V	2.2V	6V
Internal Bias (= INT B)	4	0V	0V	1.5V	2.2V	6V
External Bias (= EXT B)	12	Voltage applied to EXT BIAS input at rear panel.	Voltage applied to EXT BIAS input at rear panel.	Voltage applied to EXT BIAS input at rear panel.	Voltage applied to EXT BIAS input at rear panel.	Voltage applied to EXT BIAS input at rear panel.
BIAS 1.5V	13	0V	0V	1.5V	0V	0V
BIAS 2.2V	14	0V	0V	0V	2.2V	0V

Signal and Connector Pin No.		TRIGGER	
		INT	EXT
$\overline{MANUAL}$	10	High	Low

Signal and Connector Pin No.		CIRCUIT MODE		
		AUTO	PARA	SER
Circuit Mode A (= CMA)	6	High	Low	High
Circuit Mode B (= CMB)	7	High	Low	Low

Signal and Connector Pin No.		FUNCTION		
		L	C	R
FUNCTION A	1	High	Low	High
FUNCTION B (= FNC B)	15	High	Low	Low

Signal and Connector Pin No.		RANGE HOLD	
		OFF	ON
$\overline{Range\ Hold}$	9	High	Low

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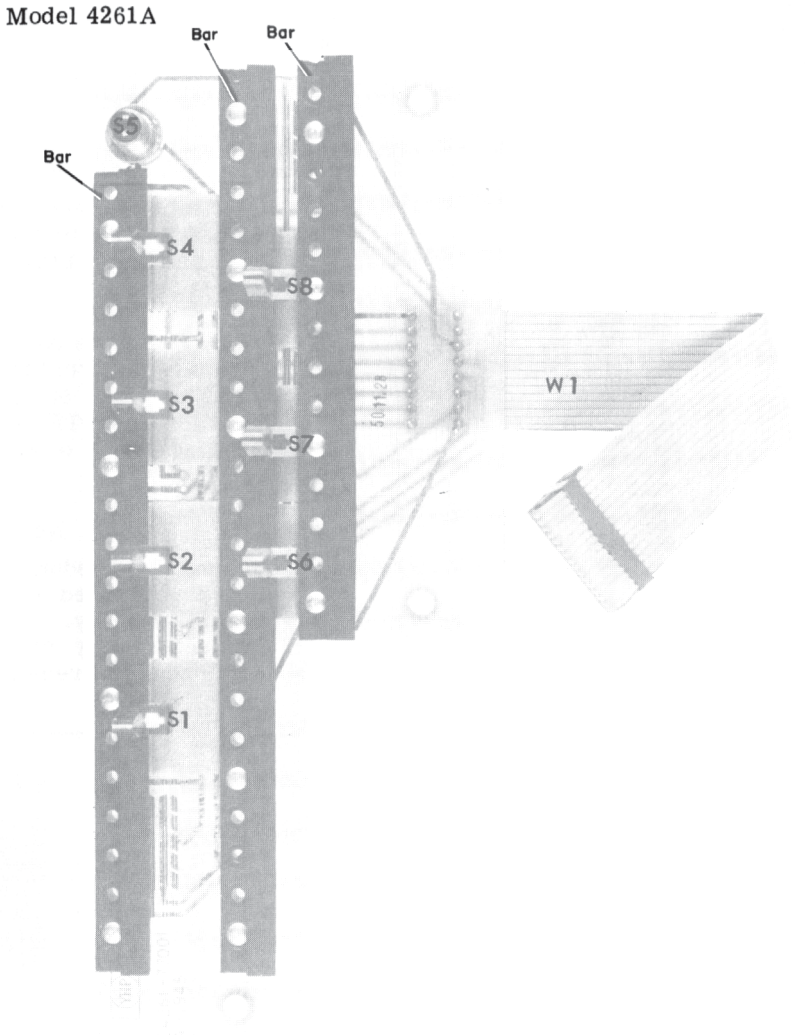

Figure 8-16. A1 Switch Board Assembly Component Locations.

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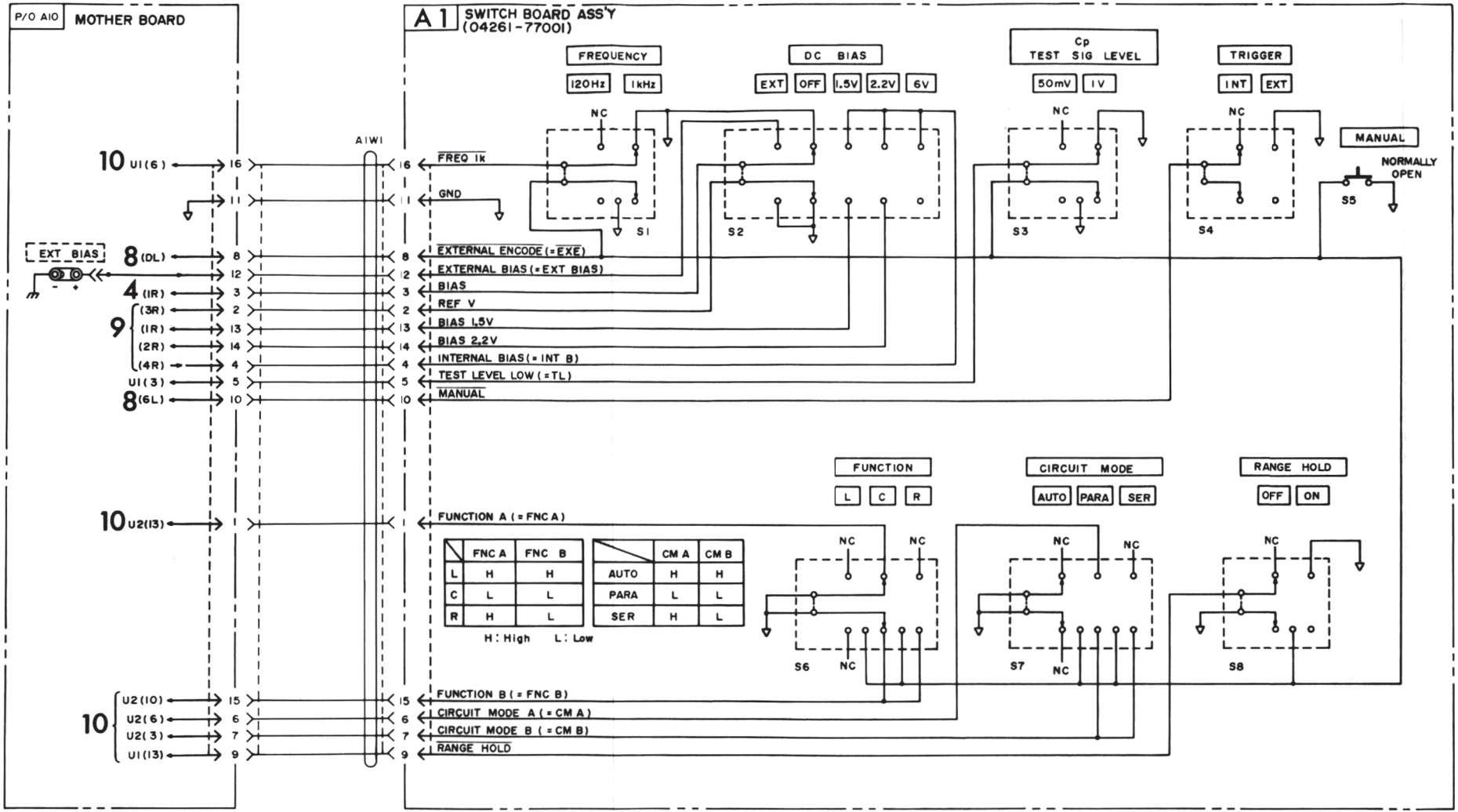

Figure 8-17. A1 Switch Board Assembly Schematic Diagram 8-55

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Note

1. This schematic shows circuit condition that exist when front panel controls are set as follows:

FREQUENCY	1kHz
DC BIAS	OFF
Cp TEST SIG LEVEL	1V
TRIGGER	INT
FUNCTION	C
CIRCUIT MODE	AUTO
RANGE HOLD	OFF

2. A1W1 includes connector plus flat cable. NC means No Connection.

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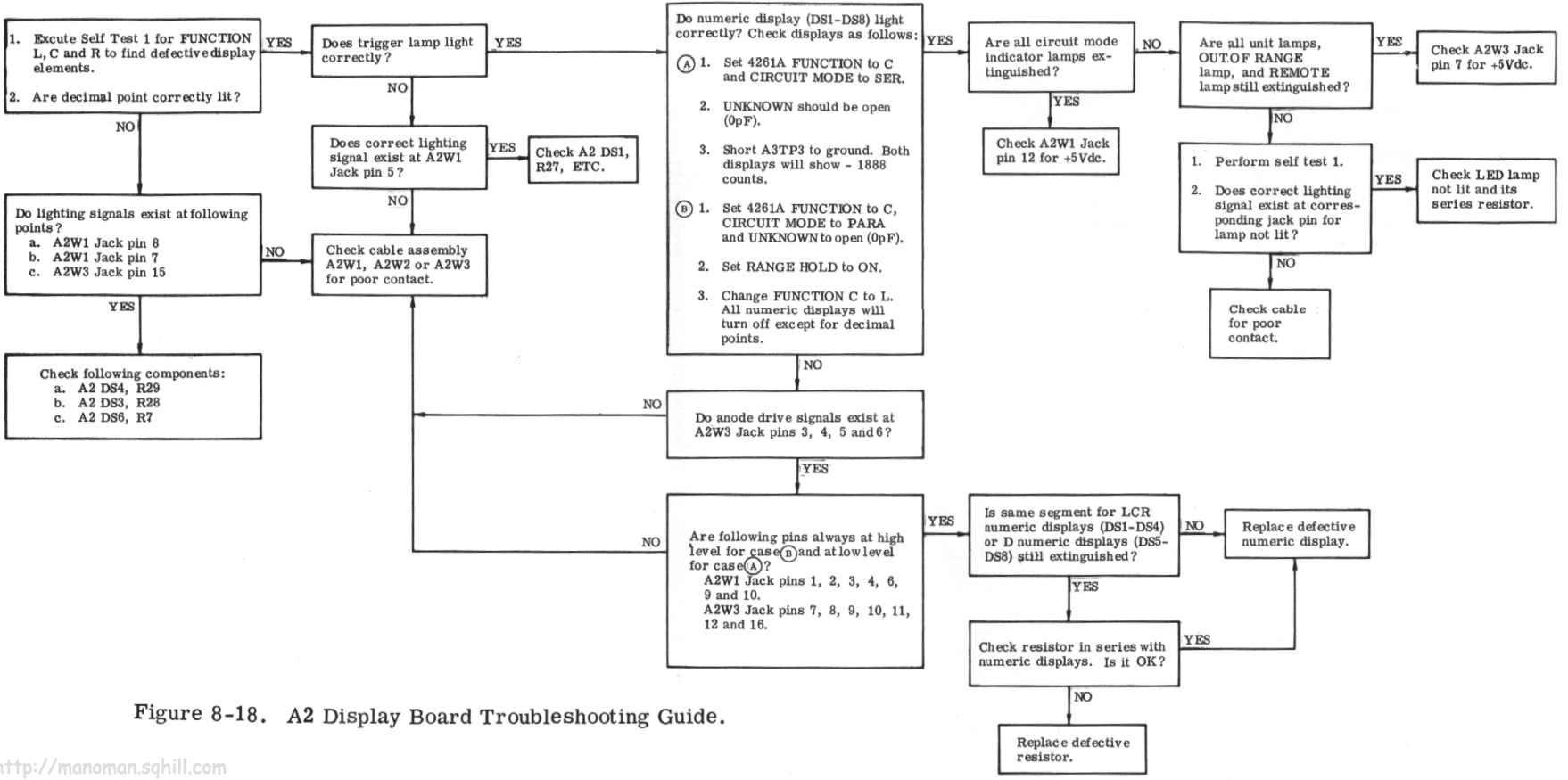

Figure 8-18. A2 Display Board Troubleshooting Guide.

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CIRCUIT DESCRIPTION

A2 Display Board Assembly receives display control signals from A3 Display Driver (via three flat cables), and displays the measured values with unit and annunciation. DS1 thru DS8 are seven-segment LED numeric displays and DS9 thru DS25 are single LED elements. All LED elements light when a TTL low signal is applied. The numeric displays (DS1 thru DS8) are driven sequentially by ANOD 1 thru ANOD 4 signals which supply dc power to each numeric display only during assigned period. LED dynamic lighting is graphically shown in Figure A below. For example, DS2 and DS6 can be lit in accordance with their control signals only when ANOD 2 signal is at high level.

TROUBLESHOOTING INFORMATION

Almost all troubles on A2 board may be found by excuting Self Test 1 (Digital Test) per procedure given below. The troubleshooting tree to be followed is also outlined.

To check displays, perform the following:

a. Remove top cover.

b. Set 4261A TRIGGER to INT and RANGE HOLD to OFF.

c. Short A3TP3 (display test) to the instrument chassis (ground).

d. Set FUNCTION to L and CIRCUIT MODE to SER. Connect nothing to UNKNOWN terminals (∞ Ω).

e. Check that all numeric displays are lit (-1888 count display). OUT OF RANGE lamp is turned on and trigger lamp turns on and off.

f. Set the slide switch mounted on A8 board (P/N: 04261-77108) to TEST 1 as shown in Figure B below.

g. When FUNCTION is set to L, C or R, check that LED elements for unit, circuit mode, and decimal point (except REMOTE) light as shown in Figure C below.

Note

Each LED element lights sequentially according to a format determined for each setting of FUNCTION switch (L, C or R).

h. REMOTE turns on only when an external device to remotely control the 4261A is connected to a 4261A Option 003 or Option 101. To check the LED's for REMOTE, ground pin 43 of REMOTE INPUT connector on rear panel (REMOTE lamp lights).

Note

Removal procedure for A2 Display Board is outlined on angle plate of A2 board assembly. This instruction label can easily be located after top cover has been removed.

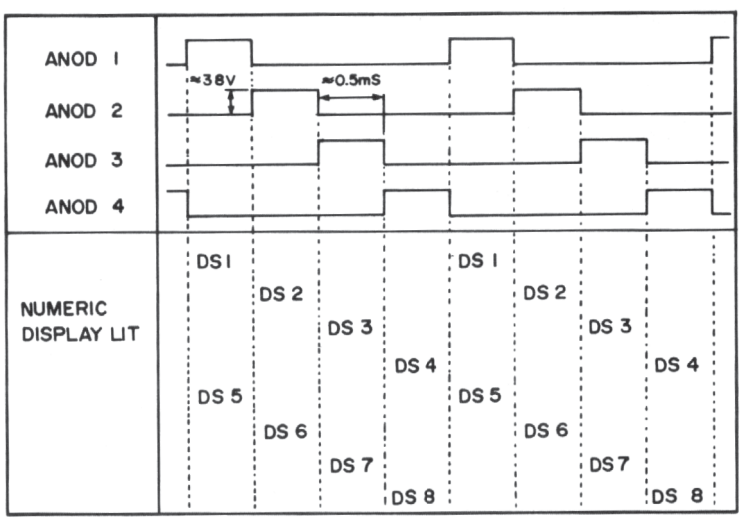
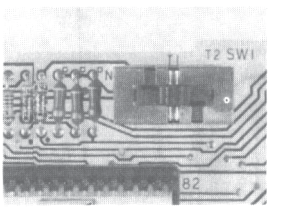


Figure A. Dynamic Lighting.

Figure C. LED Elements Lit.



Note

Set the two slide switches to TEST (T) and TEST 1 (T1), respectively, for A8 board P/N 04261-77008.

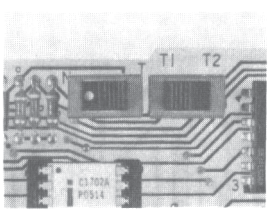


Figure B. Self Test Switch Position(s).

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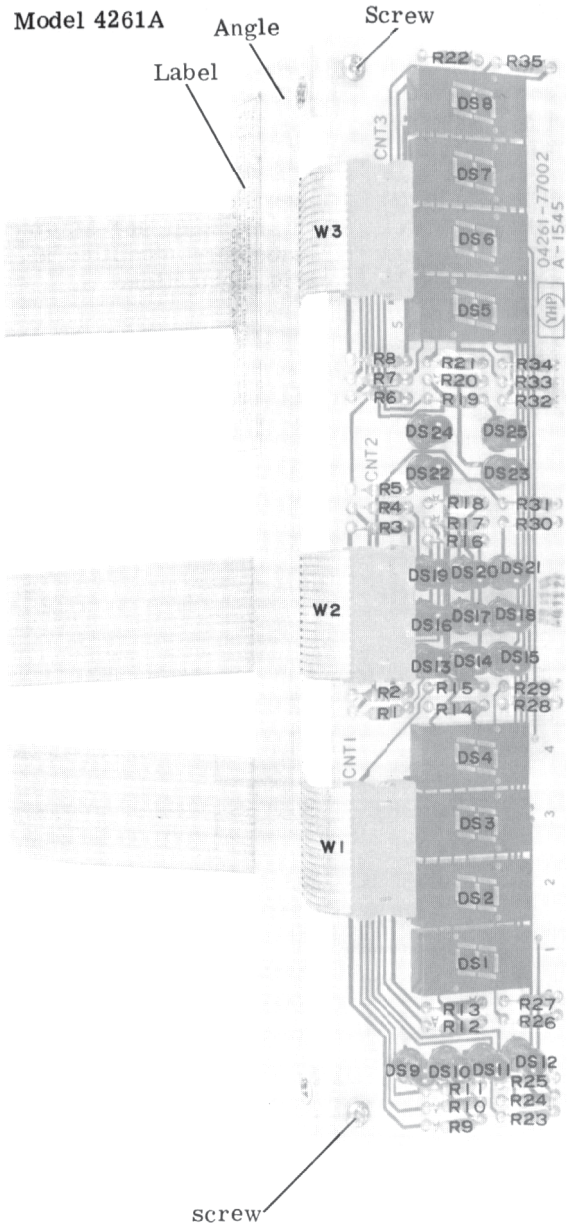

Figure 8-19. A2 Display Board Assembly Component Locations.

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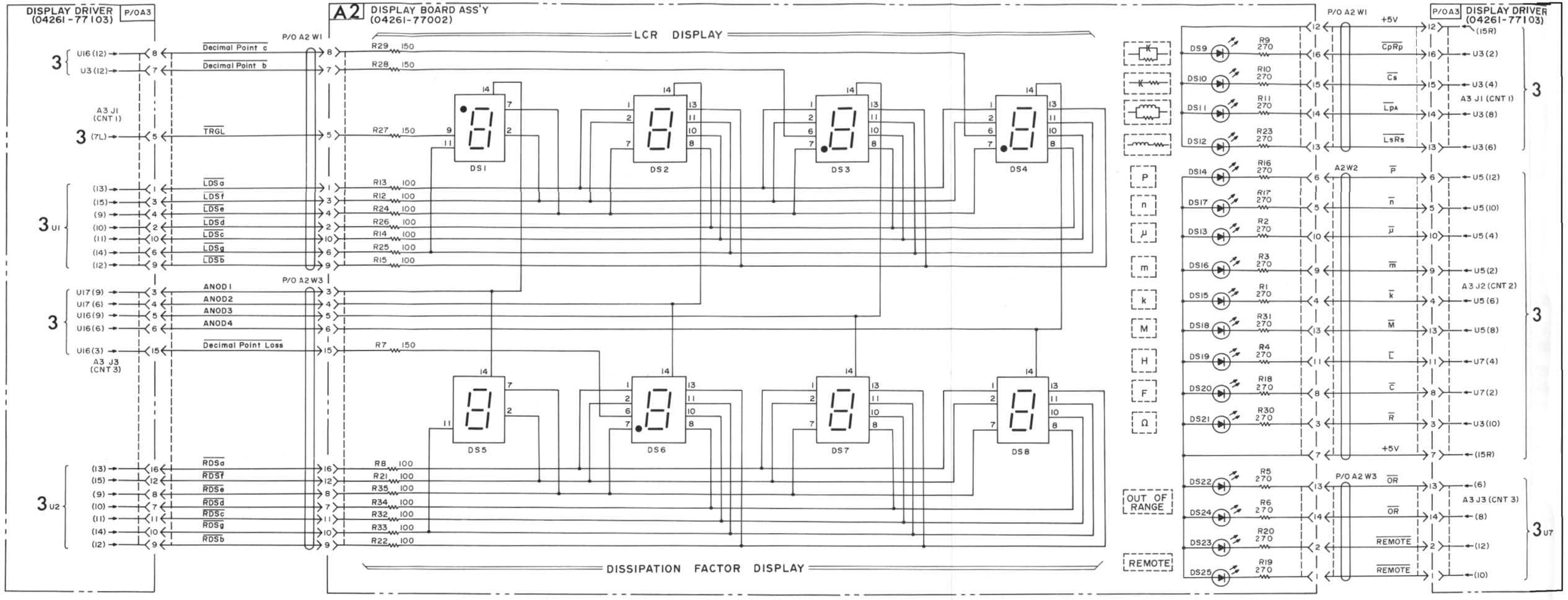
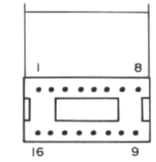


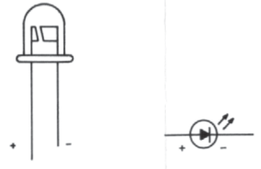
1. Pin Locations of DS1 thru DS8.

   Note that mounting positions of DS1 and DS5 are reverse to that of other numeric displays.



2. Pin Locations of W1 thru W3.

   Component side view of plug to A3 board.



3. DS9 - DS25 Polarity.

   CAUTION: Never apply stress to legs of LED during soldering, or LED will open.

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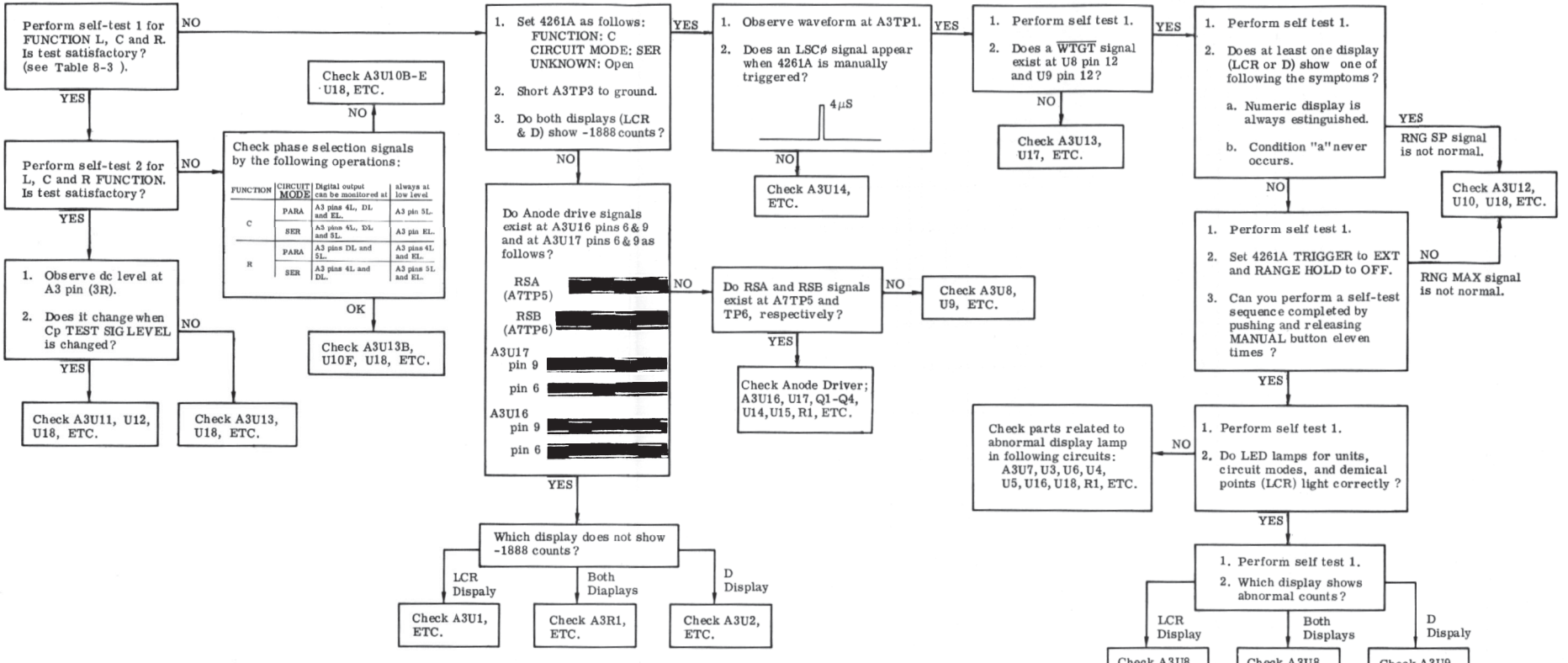

Figure 8-21. A3 Display Driver Board Troubleshooting Guide.

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CIRCUIT DESCRIPTION

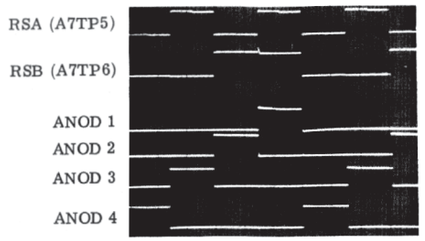
A3 Display Driver Board is functionally divided into two sections: these are the numeric display driver section and the LED lamp driver-phase decoder-range resistor decoder section. Firstly, data signals (DATA BIT 1, DATA BIT 2, DATA BIT 4, DATA BIT 8) converted to BCD code in A7 Board are inputted to U8 and U9 register files. U8 and U9 can store four BCD code signals. U8 memorizes L, C or R four-digit data BCD and U9 stores D four-digit data. These numeric data are stored on instructions of a $\overline{\text{WTGT}}$ (WRITE GATE) signal as synchronized with RSA and RSB signals. See Figure A.

BCD data stored in U8 and U9 are sent to U1 and U2 BCD to 7 segment Decoder/Driver in the order determined by RSA and RSB signals and their outputs are fed to A2 display board. At the same time, RSA and RSB signals are converted to Anode Drive signals (ANOD 1 thru ANOD 4) to dynamically light the numeric displays (U14, U15, Q1 thru Q4, U16 and U17). The read only memory (ROM) U18 has been programmed to light unit/circuit mode lamps on A2 board in proper sequence and to select range resistor on A4 board and to pass selected range information (RANGE MAX, RANGE MINIMUM, RANGE SPECIAL) to A7 board. Here, the inputs to the ROM are functions (FUNC A or FUNC B), circuit mode (CMS) and range information (SLO 1 thru SLO 4). These output data are fixed during one measurement cycle by latches U4, U6, U11 and U12 when $\overline{\text{LSC 0}}$ signal is at low level. See Figure B below.

When $\overline{\text{LSC 0}}$ signal is at high level, ROM U18 is (additionally) used to select phase of detection signal fed to phase detection on A6 board (PHASE 0, PHASE $\pi/2$, PHASE π or PHASE $3\pi/2$) and to control V TEST signal to A5 board. Input signals to the ROM are the functions (FUNC A and FUNC B), circuit mode, step and MS (measurement status) signals which are identified as SLO 1 thru SLO 4 signals in the schematics.

TROUBLESHOOTING INFORMATION

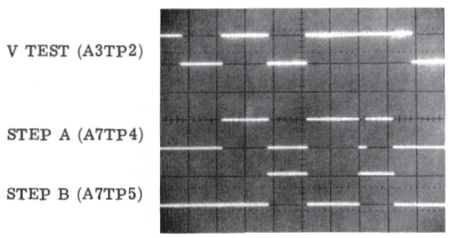
Troubleshooting tree to be followed is presented at the left.



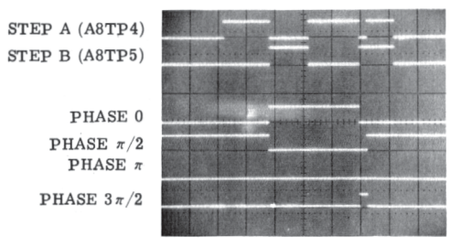
Measurement conditions:
FUNCTION C
CIRCUIT MODE..... PARA
FREQUENCY 1kHz
Cp TEST SIG LEVEL 1V
≈0.3ms/div.

Note

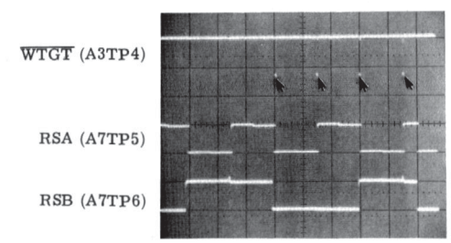
To observe waveforms ANOD 1 thru ANOD 4, connect a 500Ω resistor (approx.) between the oscilloscope probe tip and ground.



Measurement conditions:
FUNCTION C
CIRCUIT MODE..... PARA
FREQUENCY 1kHz
Cp TEST SIG LEVEL 1V
Unknown ..... .13μF
≈30ms/div.



Measurement conditions:
FUNCTION C
CIRCUIT MODE..... PARA
FREQUENCY 1kHz
Cp TEST SIG LEVEL 1V
≈20ms/div.



Measurement conditions:
FUNCTION C
CIRCUIT MODE..... PARA
FREQUENCY 120Hz
Cp TEST SIG LEVEL 1V
≈.3ms/div.

Display Board Assembly (A2)
SERVICE SHEET 2

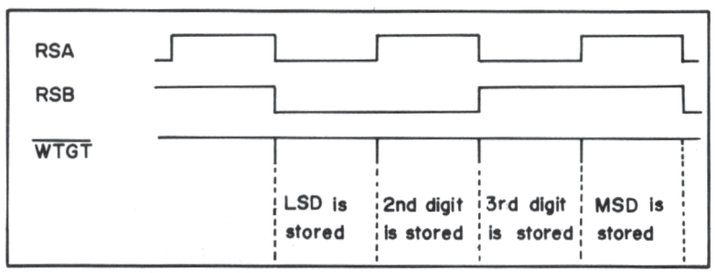


Figure A. Data Store Timing.

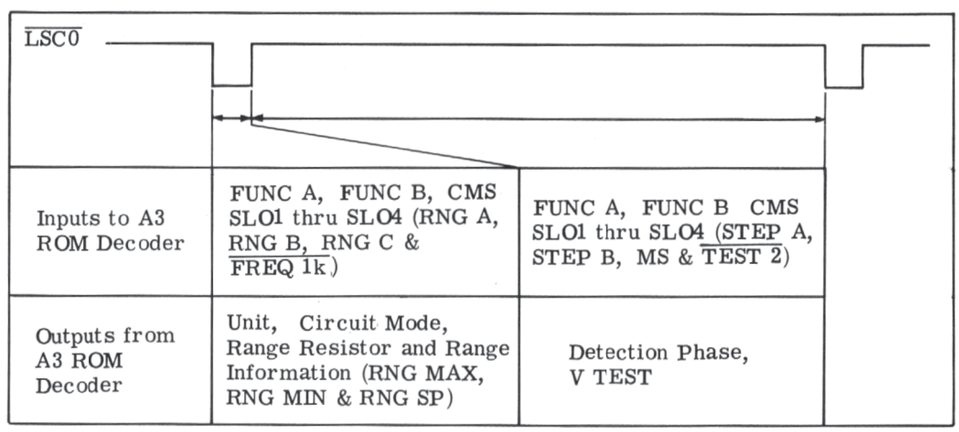


Figure B. ROM Operation.

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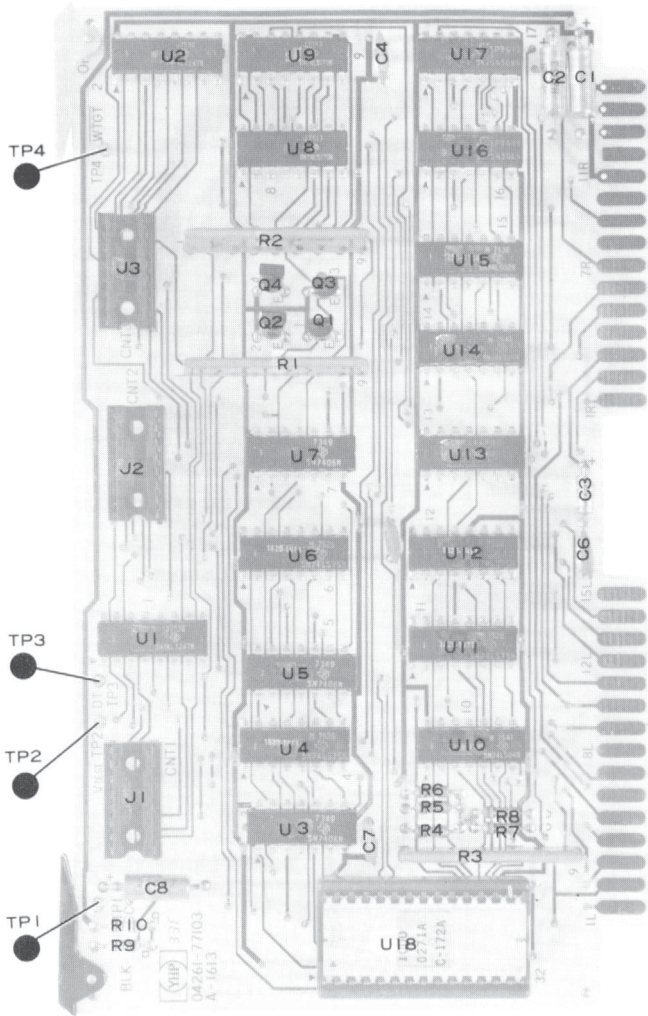

Figure 8-22. A3 Display Driver Board Assembly Component Locations.

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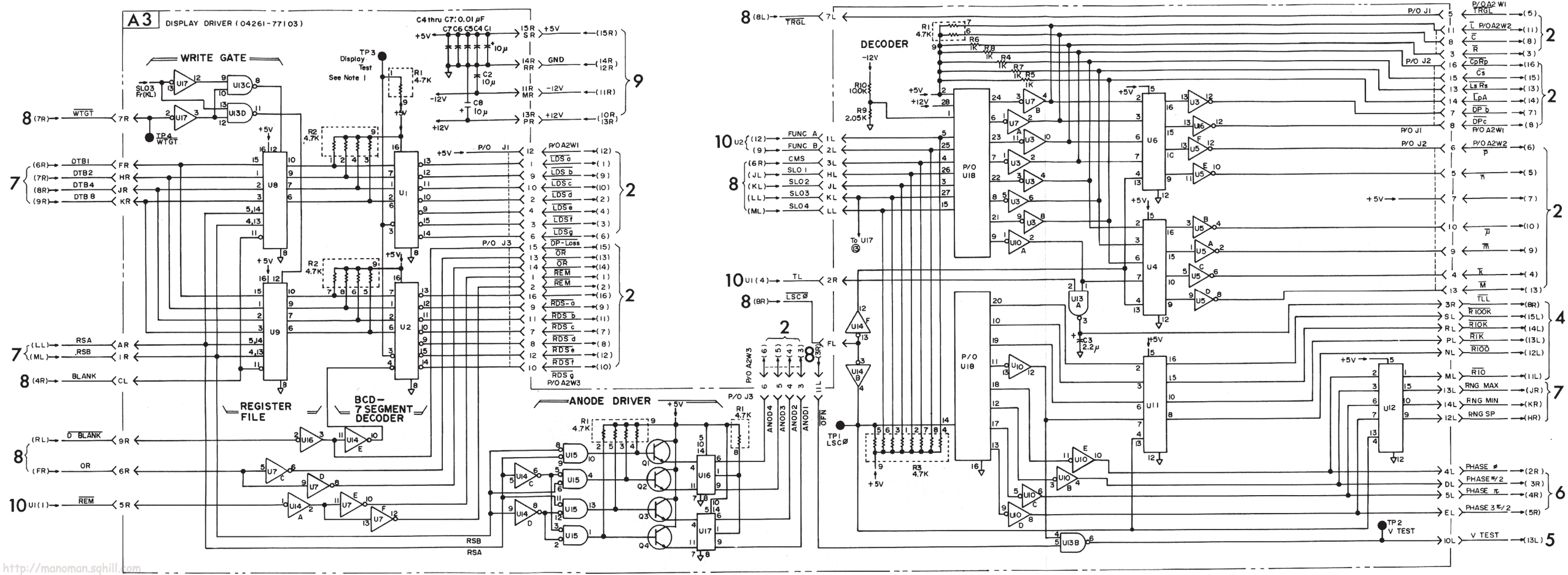

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"NOTE"

TOLERANCE VALUES GIVEN IN THIS PROCEDURE DO NOT INCLUDE MEASURING INSTRUMENT ERROR

Set 4261A as follows:
DC BIAS ..... OFF
TRIGGER ..... INT
FUNCTION C
CIRCUIT MODE..... PARA
RANGE HOLD ..... OFF

Monitor voltage level at A4TP1 with oscilloscope. When FREQUENCY is changed, are levels within following?

FREQ	LEVEL
120Hz	6.2Vpp-7.2Vpp with no visible distortion.
1kHz	6.2Vpp-7.2Vpp with no visible distortion.

NO → Check A4U1B, Q4, Q3 CR3, ETC.

YES

Monitor waveform at A4TP1. When FREQUENCY is changed are oscillator frequencies within following limits?

FREQ	Frequency (Period)
120Hz	(A) 116 - 124Hz (8.08 - 8.58ms)
1kHz	(B) 970 - 1030Hz (.97 - 1.03ms)

NO →

Test Failed	Check
(A) only or (B) only	Check dc voltage at A4Q6 collector. Is it -12V±1V for 120Hz and +2V ±1V for 1kHz? If yes, check A4CR1, CR2, Q1, Q2, ETC. If no, check A4Q6, CR4, ETC.
(A) and (B)	A4C1, C2, R2, R4-R6, Q1, Q2, CR1, CR2.

YES

Monitor waveform at A4TP2. When Cp TEST SIG LEVEL is changed are oscillator levels within following limits?

	Level
50mV	(A) 540 - 580mVpp
1V	(B) 11 - 11.5Vpp

NO →

Test Failed	Check
(A) only or (B) only	A4Q5, Q7, ETC.
(A) and (B)	A4U1A, CR5, CR6, Q8, Q9 ETC.

YES

1. Set 4261A as follows:
   FREQUENCY..... 1kHz
   Cp TEST SIG LEVEL... 1V
   TRIGGER ..... EXT
   FUNCTION..... R
   CIRCUIT MODE ..... AUTO
   RANGE HOLD ..... OFF
2. Perform self test 2.
3. Short HCUR terminal to ground.
4. Set range to 1000mΩ by pushing and releasing MANUAL switch.
5. Is positive pole level at A4C9 more than 50mVpp?

NO (< 50mVpp) →

YES → Check A4C9, CR7, ETC.

(A) 1. Observe waveform at R39--- reed relay side (1000mΩ range)
2. Is the level within 1.2Vpp - 1.6Vpp?

(B) 1. Set range to 10.00Ω with MANUAL pushbutton.
2. Is the level within 1.2Vpp - 1.6Vpp?

(A) YES and (B) NO →

(A) 1. Observe waveform at R38-- reed relay side (10Ω range).
2. Is the level within 2.6Vpp - 3.2Vpp?

(B) 1. Set range to 100.0Ω by MANUAL switch.
2. Is the level within 2.6Vpp - 3.2Vpp?

(A) NO or (B) YES ↓

Result	Action
(A) NO	1. Set range to 1000mΩ. 2. Is A4Q15 collector voltage less than +2Vdc? If yes, check A4K1, ETC. If no, check A4Q14, Q15, CR8, ETC.
(B) YES	1. Set range to 10.00Ω. 2. Is A4Q15 collector voltage more than 10Vdc? If yes, check A4K1, ETC. If no, check A4Q14, Q15, CR8, ETC.

(A) NO or (B) YES ↓

Result	Action
(A) NO	1. Set range to 10.00Ω. 2. Is A4Q13 collector voltage less than +2Vdc? If yes, check A4K2, ETC. If no, check A4Q12, Q13, CR9, ETC.
(B) YES	1. Set range to 100.0Ω. 2. Is A4Q13 collector voltage more than +10Vdc? If yes, check A4K2, ETC. If no, check A4Q12, Q13, CR9, ETC.

(A) YES and (B) NO ↑

(A) 1. Observe waveform at R35 FET side (100.0Ω range).
2. Is the level within 2.6Vpp - 3.2Vpp?

(B) 1. Set range to 1000Ω.
2. Is the level within 2.6Vpp - 3.2Vpp?

(A) NO or (B) YES →

Result	Action
(A) NO	1. Set range to 100.0Ω. 2. Is A4Q17 collector voltage more than +10Vdc? If yes, check A4K3, ETC. If no, check A4Q16, Q17, ETC.
(B) YES	1. Set range to 1000Ω. 2. Is A4Q17 collector voltage less than +2Vdc? If yes, check A4K3, ETC. If no, check A4Q16, Q17, CR10, ETC.

(A) YES and (B) NO ↑

(A) 1. Observe waveform at R33 FET side (1000Ω range).
2. Is the level within 2.6Vpp - 3.2Vpp?

(B) 1. Set range to 10.00kΩ.
2. Is the level within 2.6Vpp - 3.2Vpp?

(A) NO or (B) YES →

Result	Action
(A) NO	1. Set range to 1000Ω. 2. Is A4Q19 collector voltage more than +10Vdc? If yes, check A4K4, ETC. If no, check A4Q18, Q19, ETC.
(B) YES	1. Set range to 10.00kΩ. 2. Is A4Q19 collector voltage less than +2Vdc? If yes, check A4K4, ETC. If no, check A4Q18, Q19, CR11, ETC.

(A) YES and (B) NO ↑

1. Disconnect HCUR terminal from ground.
2. Observe waveform at HCUR terminal.
3. Is the level more than 2Vpp with no visible distortion?

NO → Check A4CR10, CR11, R88, ETC.

YES →

1. Short four unknown terminals together (Self Test 2).
2. When range is set with MANUAL pushbutton do signal levels at A4 pin 6L satisfy all ranges as shown in table to right?

RANGE	Level
1000mΩ	1.2V-1.6Vpp with no visible distortion.
10.00Ω 100.0Ω 1000Ω 10.00kΩ	2.8Vpp ±0.6Vpp with no visible distortion

No limits are satisfied. → Check A4U2, Q28, Q29, CR20-CR22, CR25, CR26 and CR4-CR7 which are connected directly to LPOTEN and LCUR terminals, ETC.

Only 1000mΩ range satisfies limit, or does not satisfy the limit. →

(A) 1. Set range to 1000mΩ.
2. Is A4Q30 collector voltage more than +2V dc?

(B) 1. Set range to 10.00Ω.
2. Is A4Q30 collector voltage less than -10Vdc?

YES → Check A4Q26, Q27, Q20, ETC.

NO → Check A4Q30, CR18, CR19, ETC.

Only both 1000mΩ and 10.00Ω ranges satisfy limit, or only 10.00Ω range does not satisfy the limit. →

(A) 1. Set range to 10.00Ω.
2. Is A4Q31 collector voltage more than +2V dc?

(B) 1. Set range to 100.0Ω.
2. Is A4Q31 collector voltage less than -10Vdc?

YES → Check A4Q24, Q25, Q20, ETC.

NO → Check A4Q31, CR16, CR17, ETC.

Only 1000mΩ, 10.00Ω and 100.0Ω ranges satisfy limit, or only 100.0Ω range does not satisfy limit. →

(A) 1. Set range to 100.0Ω.
2. Is A4Q32 collector voltage more than +2Vdc?

(B) 1. Set range to 1000Ω.
2. Is A4Q32 collector voltage less than -10Vdc?

YES → Check A4Q22, Q23, Q34, Q20, CR12, ETC.

NO → Check A4Q32, CR14, CR15, ETC.

Only 1000Ω range does not satisfy limit. →

(A) 1. Set range to 1000Ω.
2. Is A4Q33 collector voltage more than +2Vdc?

(B) 1. Set range to 10.00kΩ.
2. Is A4Q33 collector voltage less than -10Vdc?

YES → Check A4Q21, ETC.

NO → Check A4Q33, CR13, ETC.

All ranges satisfy limits. → Check A4CR7, CR23, CR24, R31, ETC.

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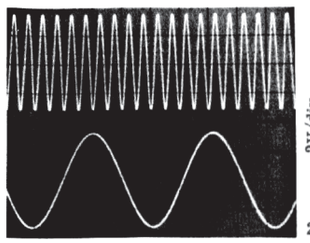
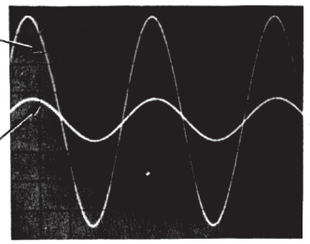
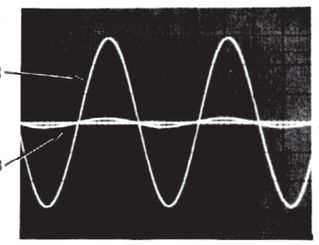
Figure 8-24. A4 Oscillator/Range Resistor Board Troubleshooting Guide.



Measurement conditions:
FUNCTION C
CIRCUIT MODE..... PARA
Cp TEST SIG LEVEL .. 1kHz
Unknown ..... Open



Measurement conditions:
FUNCTION C
CIRCUIT MODE ..... PARA
FREQUENCY 120Hz
Unknown ..... Open



Measurement conditions:
FUNCTION C
CIRCUIT MODE..... PARA
FREQUENCY 120Hz
Cp TEST SIG LEVEL 1V
Unknown ..... .12μF

Display Driver Board Assembly (A3)
SERVICE SHEET 3

CIRCUIT DESCRIPTION

The two parts of A4 are an oscillator and a range resistor section. The oscillator generates the 120Hz or 1kHz test signals using the Wien bridge technique. The range resistor section supplies a variable voltage proportional to the sample connected to UNKNOWN terminals and a constant reference voltage.

Oscillator Section. U1A, Q1 thru Q4 and associated components make up a Wien bridge oscillator with automatic level control. The 120Hz oscillator frequency is derived from the equation: $1/(2\pi\sqrt{R_5R_6C_1C_2})$. When generating the 1kHz signal, FET's Q1 and Q2 are turned on and the frequency is then derived from the formula: $1/(2\pi\sqrt{(R2//R5)\cdot(R4//R6)C1C2})$. The oscillator output level at TP1 is maintained constant at 6.8Vp-p by automatic level control circuits (Q3 and Q4) which control the gain of U1A. For example, when the oscillator output level rises above 6.8Vp-p, Q4 is turned on for a longer period, the voltage across C5 increases, and Q3 is moved nearer to an OFF condition. Therefore, the feedback to U1A increases and the gain of U1A is decreased which lowers its output level to the proper amplitude.

The oscillator output level at TP1 is attenuated to 1/20 value only when Cp mode (FUNCTION: C, CIRCUIT MODE: PARA) and 50mV are selected. U1B, Q8, Q9, CR5 and CR6 form a class B power amplifier having a voltage gain of approximately 1.8. R32, R33, R35, R87, R37 thru R39 are source resistors through which the test signal is applied to the device under test, and they are automatically selected as appropriate to the device under test (DUT). The resistance of the 100Ω and 10Ω source resistances include not only the resistance of resistances R37 thru R39 but also include the output resistance of transformer T1. The circuit which protects the DUT against excessive dc bias voltage is formed by R31, R84, C9 and CR7. The circuit, which includes R88, CR10 and CR11, protects the 4261A internal circuitry from high voltages which may invade the instrument through the UNKNOWN terminals.

Range Resistor Section. The purpose of the amplifier consisting of U2, Q28, Q29, CR20 and CR21 is to cause the same current flowing in the unknown device to flow through the range resistor. The result of this drive, is to bring the potential at the low terminals to approximately zero volts. The feedback to amplifier is taken from the range resistor which is automatically selected by the range resistor selecting circuitry as directed by selection signals ($\overline{R10}$, $\overline{R100}$, $\overline{R1k}$, $\overline{R10k}$ or $\overline{R100k}$) from the A3 Display Driver and Range Control sections. Table below shows the relationship of selected source and range resistors to the 4261A FUNCTION, CIRCUIT MODE and Range Settings. At any setting, both the range resistor (R_R) and source resistor (R_O) have the same value.

TROUBLESHOOTING INFORMATION

If troubles occur, it is recommended you follow the troubleshooting tree presented here.

Table A. Range Resistor (R_R) and Source Resistors (R_O) Selections.

FUNCTION \ Range			1	2	3	4	5	6	7	8
L	Full-scale	120Hz	1000 μH	10.00mH	100.0mH	1000 mH	10.00 H	100.0 H	1000 H	1000 H
		1kHz	100.0μH	1000 μH	10.00mH	100.0mH	1000 mH	10.00 H	100.0 H	100.0 H
	R_R, R_O	SER	10Ω	100Ω	1kΩ	10kΩ	100kΩ			
		PARA				10 Ω	100 Ω	1kΩ	10kΩ	10kΩ
C	Full-scale	120Hz	1000 pF	10.00 nF	100.0 nF	1000 nF	10.00 μF	100.0μF	1000 μF	10.00mF
		1kHz	100.0pF	1000 pF	10.00 nF	100.0 nF	1000 nF	10.00μF	100.0μF	1000 μF
	R_R, R_O	PARA	100kΩ	10kΩ	1kΩ	100Ω	10Ω			
		SER				100kΩ	10kΩ	1kΩ	100Ω	10Ω
R	Full-scale	120/1kHz	1000 mΩ	10.00 Ω	100.0 Ω	1000 Ω	10.00 kΩ	100.0 kΩ	1000 kΩ	10.00MΩ
	R_R, R_O	SER	10Ω	100Ω	1kΩ	10kΩ	100kΩ			
		PARA				10 Ω	100 Ω	1kΩ	10kΩ	100kΩ

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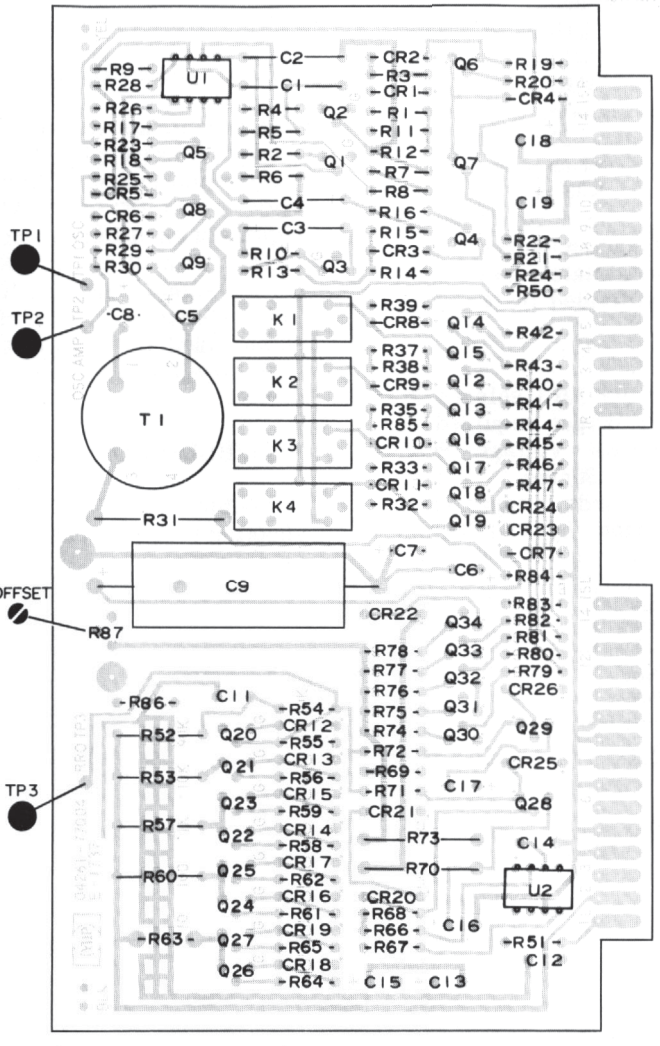

Figure 8-25. A4 Oscillator/Range Resistor Board Assembly Component Locations.

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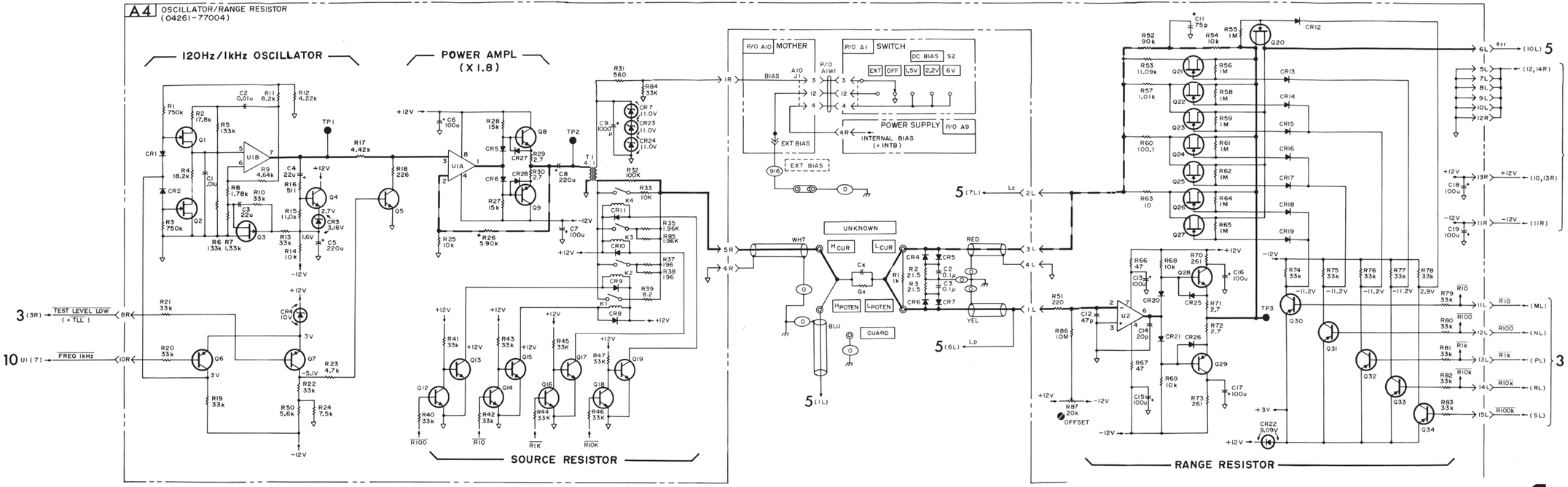

Figure 8-26. A4 Oscillator/Range Resistor Board Assembly Schematic Diagram.

Note

1. Protective diodes CR4 thru CR7 and resistor R1 are mounted directly between unknown terminals and chassis inside the front panel.
2. Voltages denoted on the schematics are values under the following control settings:

FREQUENCY	1kHz
DC BIAS	OFF
Cp TEST SIG LEVEL	1V
FUNCTION	C
CIRCUIT MODE	AUTO
RANGE HOLD	OFF
Unknown	open

4
A4, A1, A9, A10

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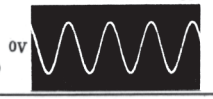
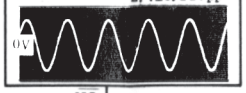
1. Set 4261A as follows:
   FREQUENCY 1kHz
   DC BIAS ..... OFF
   Cp TEST SIG LEVEL . 1V
   TRIGGER ..... INT
   FUNCTION ..... R
   CIRCUIT MODE ..... AUTO
   RANGE HOLD ..... OFF
   UNKNOWN ..... Open (∞ Ω)

2. Monitor signal at A5TP1. Does it look like this?



NO → Monitor signal at A5U1 pin6 with oscilloscope. Does it look like this?



NO → Check A5U1, C1, R23, ETC.

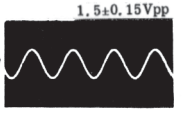
YES → Monitor signal at A5U2 pin 7. Does it look like this?

NO → Check A5U2A, R26, C3, ETC.

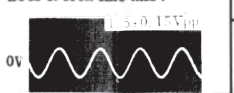
YES → Check A5U2B and associated resistors.

YES

1. Short UNKNOWN terminals together (0Ω).
2. Monitor signal at A5TP2 with oscilloscope. Does it look like?

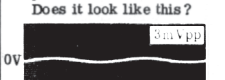


NO → Monitor signal at A5U3 pin 6. Does it look like this?



NO → Check A5U3, C4, R32, ETC.

YES → Monitor signal at A5U4 pin 1. Does it look like this?



NO → Check A5U4A, R35, ETC.

YES → Check A5U4B and associated resistors.

YES

Check Following dc voltages:

Ⓐ DC level at Q2 collector should be:

CIRCUIT MODE	PARA	SER
DC Voltage	-12V	+3V

Ⓑ Set 4261A TRIGGER to INT. DC level at Q4 collector should change from +3V to -12V or from -12V to +3V.

Ⓒ Set 4261A FUNCTION to C and CIRCUIT MODE to PARA. DC level at Q5 collector should be:

Cp TEST SIG LEVEL	50mV	1V
DC Voltage	+3V	-12V

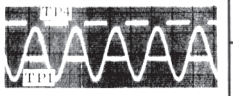
Ⓓ DC level at Q8 collector should change from +3V to -12V or from -12V to +3V.

Failed

Test Failed	Check
Ⓐ	A5Q1, Q2 and associated resistors.
Ⓑ	A5Q3, Q4 and associated resistors.
Ⓒ	A5Q5 and associated resistors.
Ⓓ	A5Q7, Q8 and associated resistors.
Ⓐ thru Ⓟ	A5CR3, R1, ETC.

OK →

1. Set 4261A FUNCTION to C, CIRCUIT MODE to PARA.
2. Open UNKNOWN terminals (∞Ω).
3. Monitor signals at A5TP1 and TP4. Do they look like this?



YES →

1. Set FUNCTION to C and Cp TEST SIG LEVEL to 50mV.
2. Monitor signal level at A5TP3. Are the following signal levels satisfied?

UNKNOWN	CIRCUIT MODE	Signal Level
Open	PARA	Ⓐ 3.0 ±0.15Vpp and 0 volts are intermittently displayed.
	SER	Ⓑ 20 ±2Vpp and 0 volts are intermittently displayed.
short	PARA	Ⓒ 17 ±1.7Vpp, and 0 volts are intermittently displayed.
	SER	Ⓓ 1.7±0.17Vpp and 0 volts are intermittently displayed.

NO →

Test Failed	Check
Ⓐ	A5Q10, CR6, CR7, R40, ETC.
Ⓑ	A5Q9, CR4, CR5, ETC.
Ⓒ	A5Q11, CR8, CR9, ETC.
Ⓓ	A5Q12, CR10, CR11, ETC.
Ⓐ thru Ⓓ	Monitor A5U5 pin 1. Set 4261A FUNCTION : C CIRCUIT MODE : PARA UNKNOWN : Open Are 3.0±0.15Vpp and 0 volts intermittently displayed? If yes, check U5B, Q15, CR14, ETC. If no, check U5A and associated resistors.

YES →

1. Set FUNCTION to C and CIRCUIT MODE to SER.
2. Open UNKNOWN terminals (∞Ω).
3. Monitor signal at A5U7 pin9. Does it look like this?

YES → Check A5Q19, Q20, CR20, CR21, ETC.

NO → Check Comparator; A5U7, R67 thru R72, ETC.

Is dc level at A5TP1 and TP2 almost 0 volts (≦±10mV)?

NO → Check A5R31, R41, ETC.

YES →

1. Set FUNCTION to C.
2. Monitor level at A5U6 pin1. Is following satisfied?

CIRCUIT MODE	PARA		SER
UNKNOWN	Open		Short
Cp TEST SIG LEVEL	50mV	1V	1V
Signal Level	Ⓐ 2.7± 0.14Vpp	Ⓑ 2.7± 0.14Vpp	Ⓒ 1.5± 0.08Vpp

YES → Monitor signal at A5U6 pin 7. Does it look like this?

YES → Check A5U8, CR22, ETC.

NO → Check A5U6B, CR18, CR19, ETC.

NO →

Test Failed	Check
Ⓐ only	A5Q17, CR16, ETC.
Ⓑ and Ⓒ	
Ⓒ only	A5Q14, CR13, ETC.
Ⓐ and Ⓑ	A5Q13, CR12, ETC.
Ⓐ, Ⓑ and Ⓒ	A5U6A, R60, ETC.

Figure 8-27. A5 Process Amplifier Board Troubleshooting Guide.

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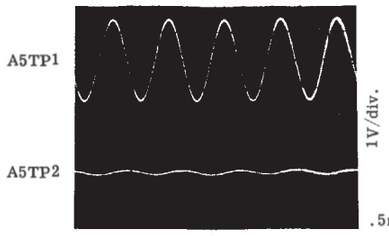
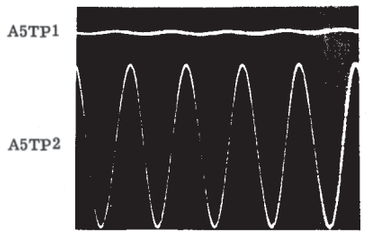
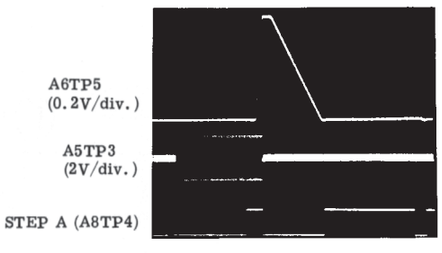


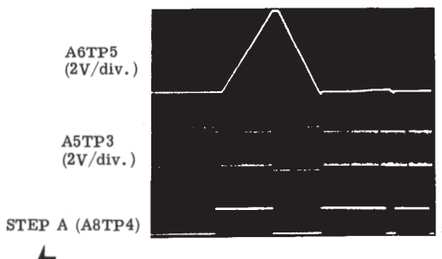
Measurement conditions:
FUNCTION C
CIRCUIT MODE ..... PARA
FREQUENCY 1kHz
Cp TEST SIG LEVEL 1V
Unknown ..... .13μF



Measurement conditions:
FUNCTION C
CIRCUIT MODE ..... SER
FREQUENCY 1kHz
Cp TEST SIG LEVEL 1V
Unknown ..... .12μF



Measurement conditions:
FUNCTION C
CIRCUIT MODE ..... SER
FREQUENCY 1kHz
Cp TEST SIG LEVEL 1V
Unknown ..... .12μF



Measurement conditions:
FUNCTION C
CIRCUIT MODE ..... PARA
FREQUENCY 1kHz
Cp TEST SIG LEVEL 1V
Unknown ..... .13μF

Oscillator/Range Resistor Board Assembly (A4)
SERVICE SHEET 4

CIRCUIT DESCRIPTION.

A5 Process Amplifier Board receives analog signals Hp (from H_{POTEN} terminal), Lp (from L_{POTEN} terminal through the mother board), L'c and e_{rr} (from A4 board through the mother board), and outputs e_m and e_{ref} signals to the A6 board. Operational amplifiers U1 thru U4 are buffer amplifiers which present a high input impedance to the analog input signals. RC networks (R23, C2, R26, C3, R35 and C5) preceding the buffer amplifiers restrict high frequency noise (which affects the measurement accuracy) from entering the instrument through the UNKNOWN terminals. C1 and C4 are dc voltage blocking capacitors. Differential amplifiers U2B and U4B amplify the differences between Hp and Lp signals, and between e_{rr} and L'c signals, respectively. The voltage gain of the differential amplifiers is set to precisely one by external resistors R24, R25, R33 and R34 which have an accuracy of ±0.05 percent. An offset adjustment circuit maintains the output dc level of the differential amplifiers to approximately zero volts. The output of the amplifier is divided by ten by resistors R41 thru R44.

Signal selector circuit Q9 through Q13 selects appropriate differential amplifier output required for measurement by control signals Voltage Select (V TEST) and Circuit Mode Series (= CMS) which are fed from A3 and A8 boards, respectively. Figure A shows signal selection by V TEST and CMS signals. The e_m signal selected by Signal Selector Circuits is amplified by U5A and U5B and fed to A6 Phase Detector and Integrator board. e_{ref} signal is amplified by U6A and is then converted to a pulse train by wave shaping circuits U6B and U8. APAO (Auto Phase Adjustment Output) signal is applied to input of U6B through R66 to control the duty cycle of e_{ref} signal for auto phase adjustment. CR18 and CR19 are used for clamping. U7 is a window comparator which outputs SAT (Saturation) signal to A8 Board when voltage level at A5TP3 exceeds ±5 volts. In this board, the dc power supply line is divided into three channels to avoid mutual interaction.

AUTO PHASE ADJUSTMENT (PHASE CONTROL).

The waveforms drawn in solid lines in Figure B are those that exist when 0V DC input (APAO) is applied. Waveforms in dotted lines are those that are present when a plus DC input (APAO) is applied. When AC signals with different dc levels are inputted, e_{ref} signals with different duty factors are generated as the AC signals are amplified with respect to a fixed (0V) reference. Therefore, the phase of the PLL output used for phase detection will vary since the PLL circuits detect only the trailing edge of an e_{ref} signal.

TROUBLESHOOTING INFORMATION.

If troubles occur, it is recommended that the troubleshooting tree presented at the left be followed.

CMS signal	PARALLEL		SERIES	
VTST signal				
Signal for e_m	Signal at A5TP2	Signal at A5TP1 / 10	Signal at A5TP1	Signal at A5TP2 / 10
Signal for e_{ref}	Signal at A5TP1		Signal at A5TP2	

Figure A. Signal Selection.

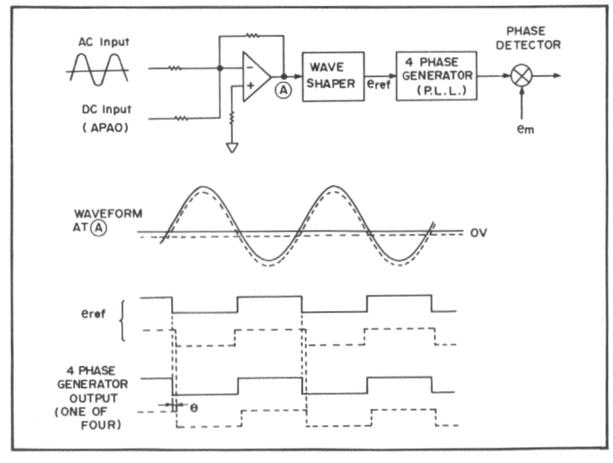


Figure B. Auto Phase Adjustment.

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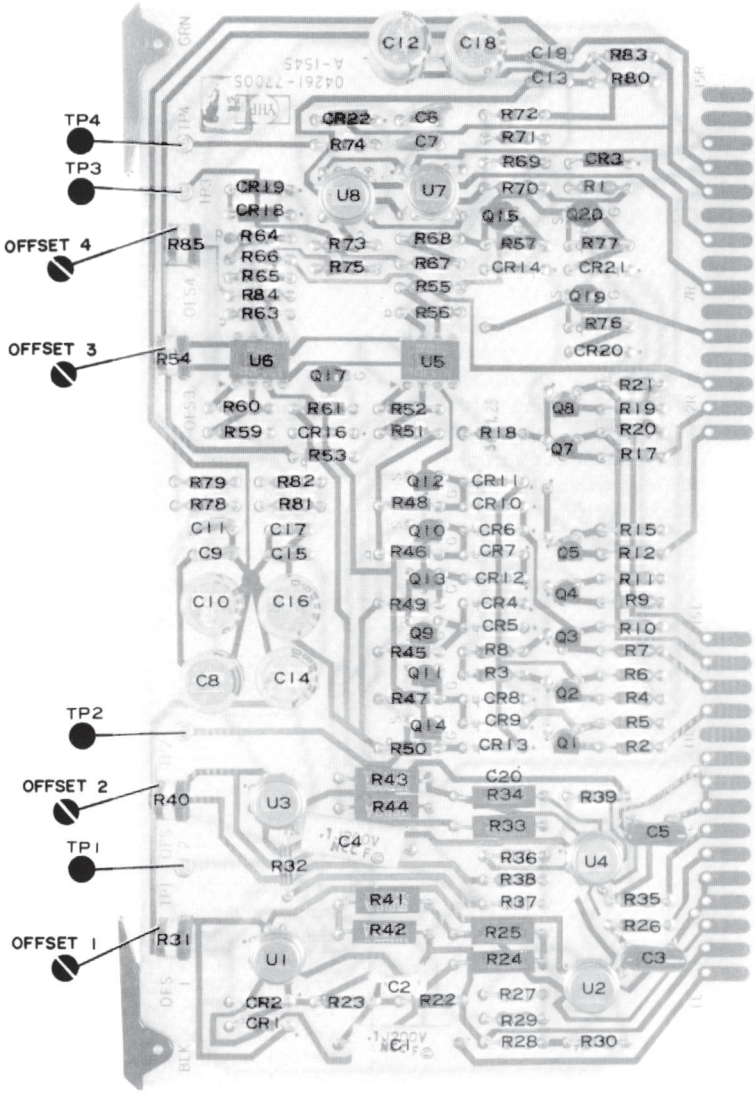

Figure 8-28. A5 Process Amplifier Board Assembly Component Locations.

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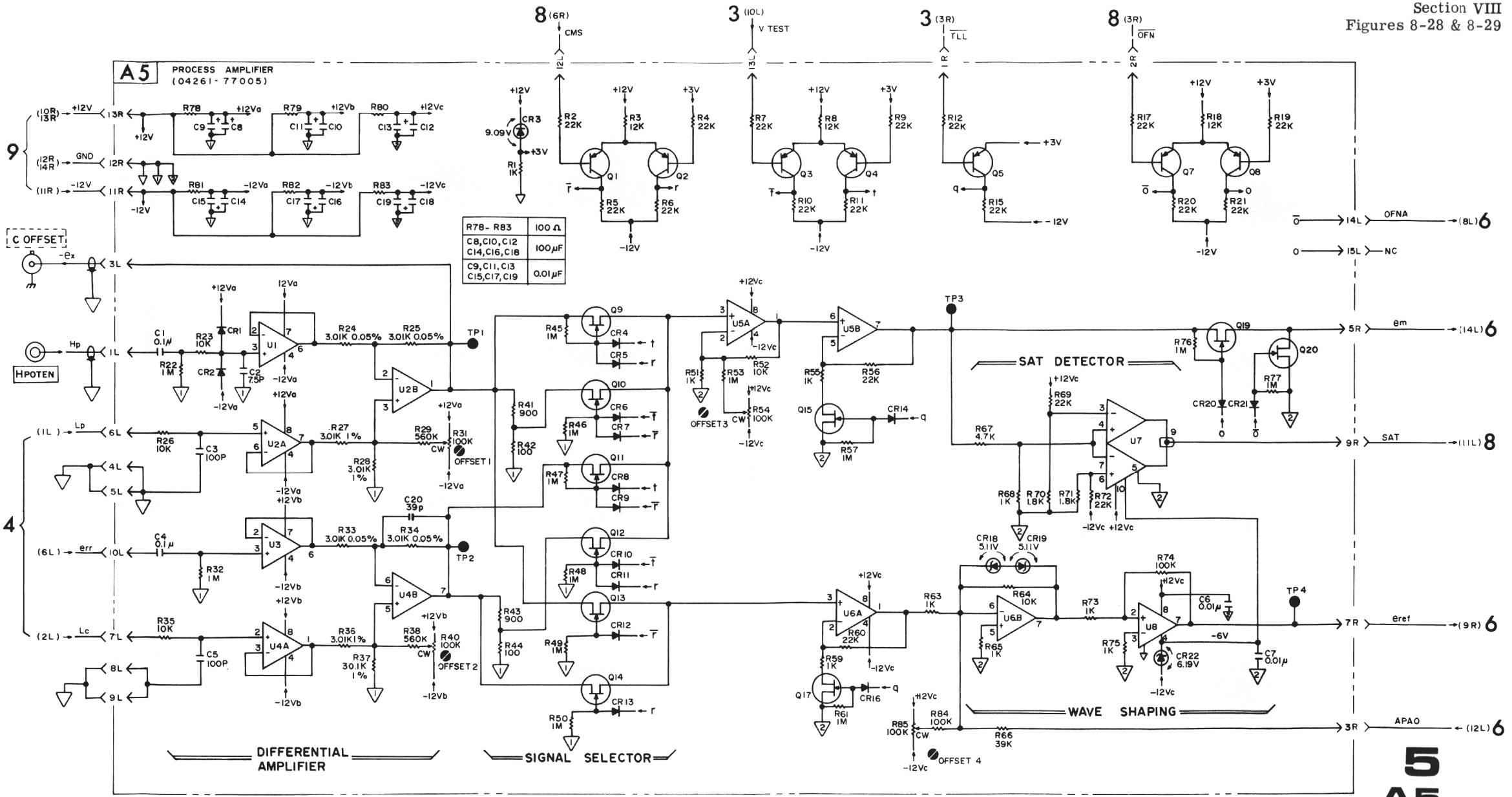

Figure 8-29. A5 Process Amplifier Board Assembly Schematic Diagram. 8-63

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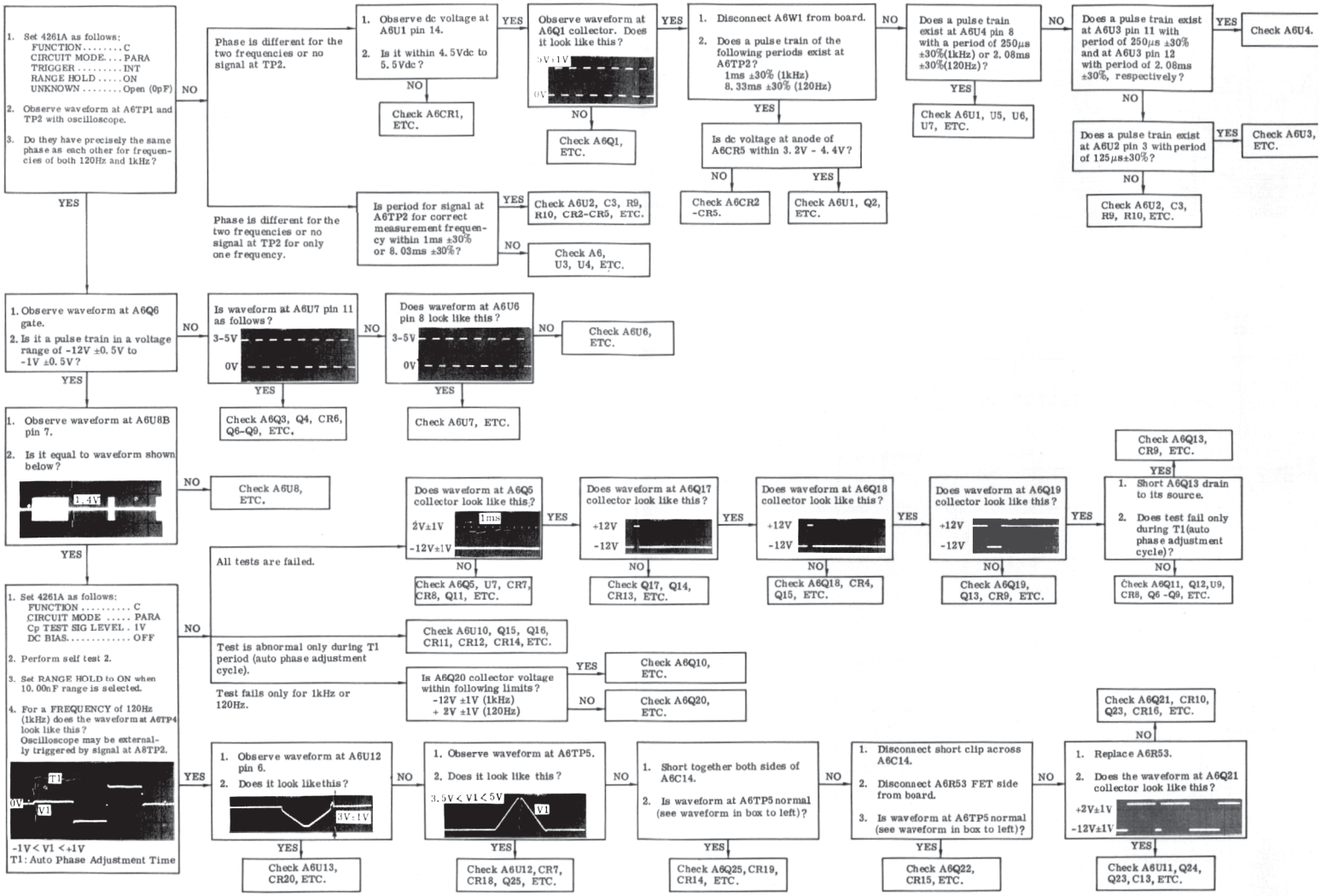
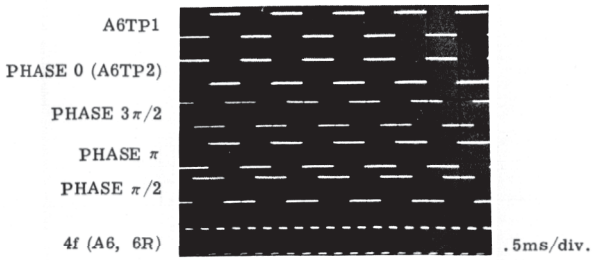
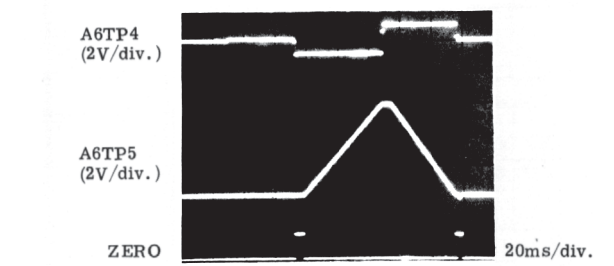


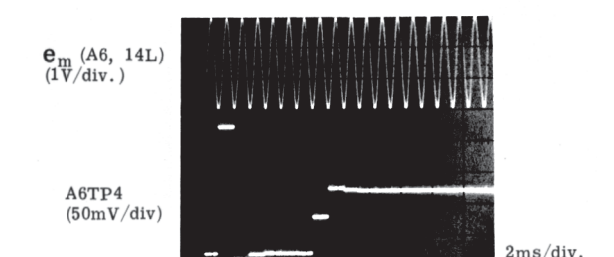
Figure 8-30. A6 Phase Detector/Integrator Board Troubleshooting Guide.



Measurement conditions:
FUNCTION C
CIRCUIT MODE..... PARA



Measurement conditions:
FUNCTION C
CIRCUIT MODE..... PARA
FREQUENCY 1kHz
Cp TEST SIG LEVEL 1V
Unknown ..... .13μF



Measurement conditions:
FUNCTION C
CIRCUIT MODE..... PARA
FREQUENCY 1kHz
Cp TEST SIG LEVEL 1V
Unknown ..... Open

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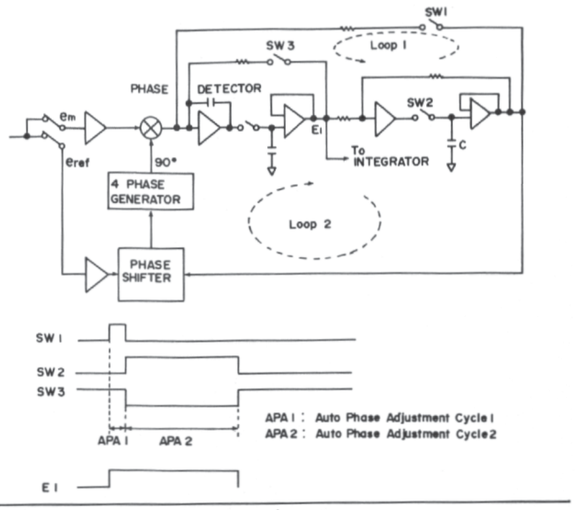


Figure D. Auto Phase Adjustment.

The Auto Phase Adjustment is automatically performed to minimize the measurement error due to detection phase error. In the APA2 (Auto Phase Adjustment Cycle 2) period, the same signal is applied to both the phase detector and the phase shifter, and the four phase generator outputs a 90 degree phase shifted pulse. If any phase error exists between e_m and e_{ref} signals, the phase detector outputs an E1 signal which is the integrator output for such error signal. This E1 signal is amplified by the amplifier which follows. The output of this amplifier is sent to a phase shifter to adjust the phase of the 4 phase generator output so that the phase error is minimized. The operation discussed above is performed with Loop 2 (SW3: OFF, SW2: ON). After the APA2 period, SW3 is closed and SW2 is turned off to memorize the dc voltage (phase control signal) stored in capacitor C which will be maintained during the measurement. For APA1 (Loop 1, Auto Phase Adjustment Cycle 1) period done prior to APA2, SW1 is closed to provide a phase control signal to the phase detector. APA1 establishes the proper condition for phase adjustment of phase detector and helps to achieve a shorter auto phase adjustment cycle. APA1 and APA2 are performed before every measurement and establish the condition for minimum phase error between the e_m and e_{ref} channels.

Figure D. Auto Phase Adjustment

Process Amplifier Board Assembly (A5)
SERVICE SHEET 5

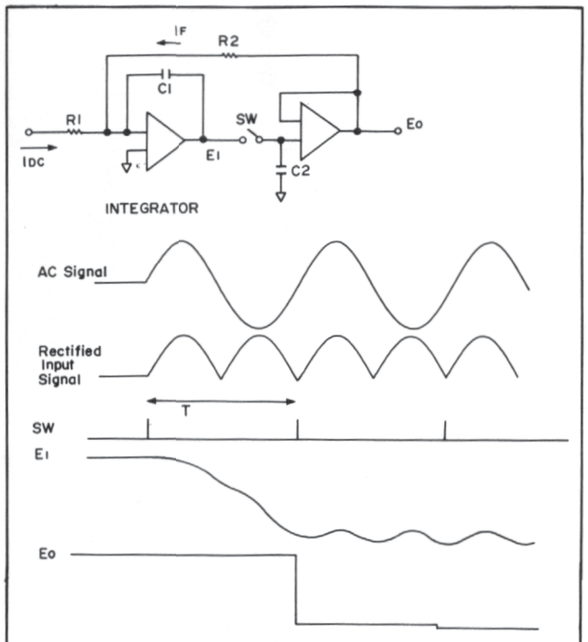
CIRCUIT DESCRIPTION

A6 Phase Detector and Integrator board assembly receives e_{ref} and e_m signals from A5 Process amplifier. These signals are converted into signals required for the measurement by control signals from logic circuits. The output of this board is the ZERO signal detected by the zero detector. The ZERO signal establishes the point at which the measurement is taken. It is sent on to the logic section for further processing. e_{ref} signal pulse trains are first multiplied to four times their frequency, by the Phase Locked Loop Circuits, U1 thru U5, Q1 thru Q3, etc. Then these 4f pulse trains are converted to four square wave signals, each having an exact phase difference of 0°, 90°, 180° and 270° with respect to the negative edge of the e_{ref} signal. One of the four pulse trains is appropriately selected by a phase selection signal (PHASE 0, PHASE $\pi/2$, PHASE π, or PHASE $3\pi/2$) from A3 board, amplified by Q3 and Q4 circuits and applied to phase detector circuit U8, Q6 thru Q9.

The Phase Detector is a kind of the AC to DC converter using a period averaging technique (U9, Q11, etc.) which is further discussed below. Integrator circuit (Q24, U11, etc.) receives the output of the phase detector and integrates this signal. The integrator output about the zero volt level is amplified by U12 amplifier whose output is sent to zero comparator whose output is +3.4Vdc only when the integrator output is in the minus voltage region.

TROUBLESHOOTING INFORMATION

The troubleshooting tree (guide) for A6 board is presented at the left.



A period averaging technique was adopted to get pure dc voltage at high speed from a signal having a large ac component. The figure above shows the full-wave rectified current input signal to this circuit. During the first T period, the input current is first integrated by the integrator. At the end of this period, the integrator output E1 is proportional to the dc current of the input signal since T is equal to one period of the input ac signal. After the first T period, the E1 signal is transferred to C2 by instantaneously short-circuiting SW and E_O (period averaging circuit output) becomes a step function. As the feed-back current (I_F) from E_O to the integrator is designed to be almost equal to I_{DC} (input current to the period averaging circuit), the difference between I_{DC} and I_F is integrated during the next (T) integrating period so that output voltage E_O becomes exactly proportional to I_{DC}. After two or three periods, E_O will be a pure dc signal having no ac component and be precisely proportional to (I_{DC}) the dc input current.

Figure A. Period Averaging Technique.

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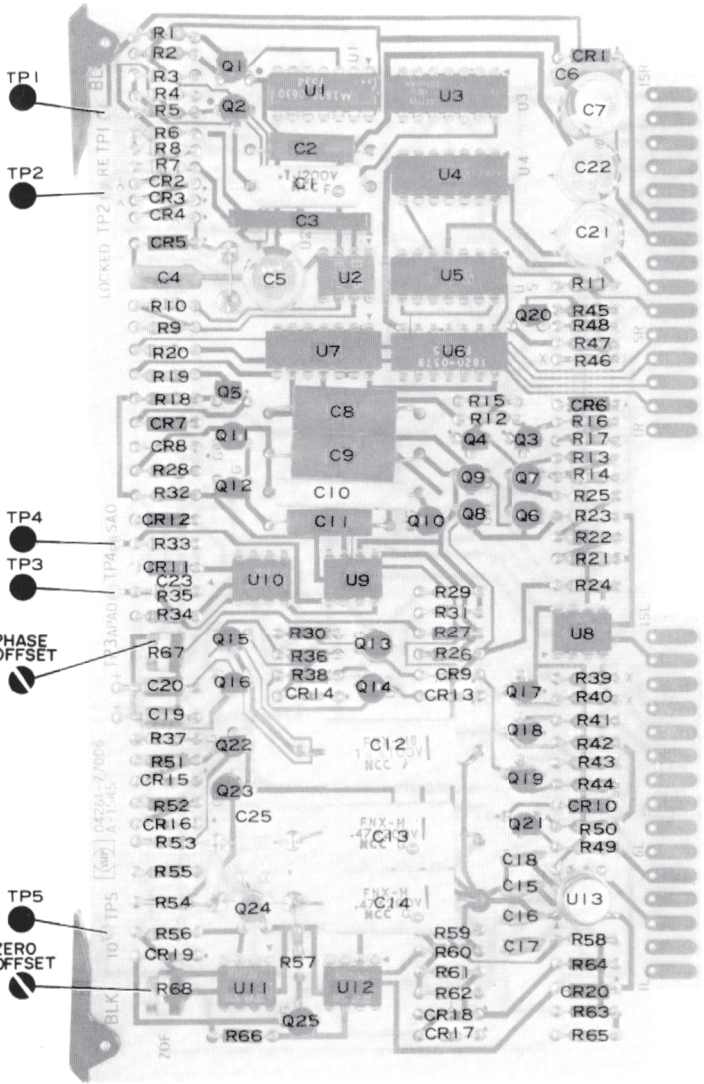

Figure 8-31. A6 Phase Detector/Integrator Board Assembly Component Locations.

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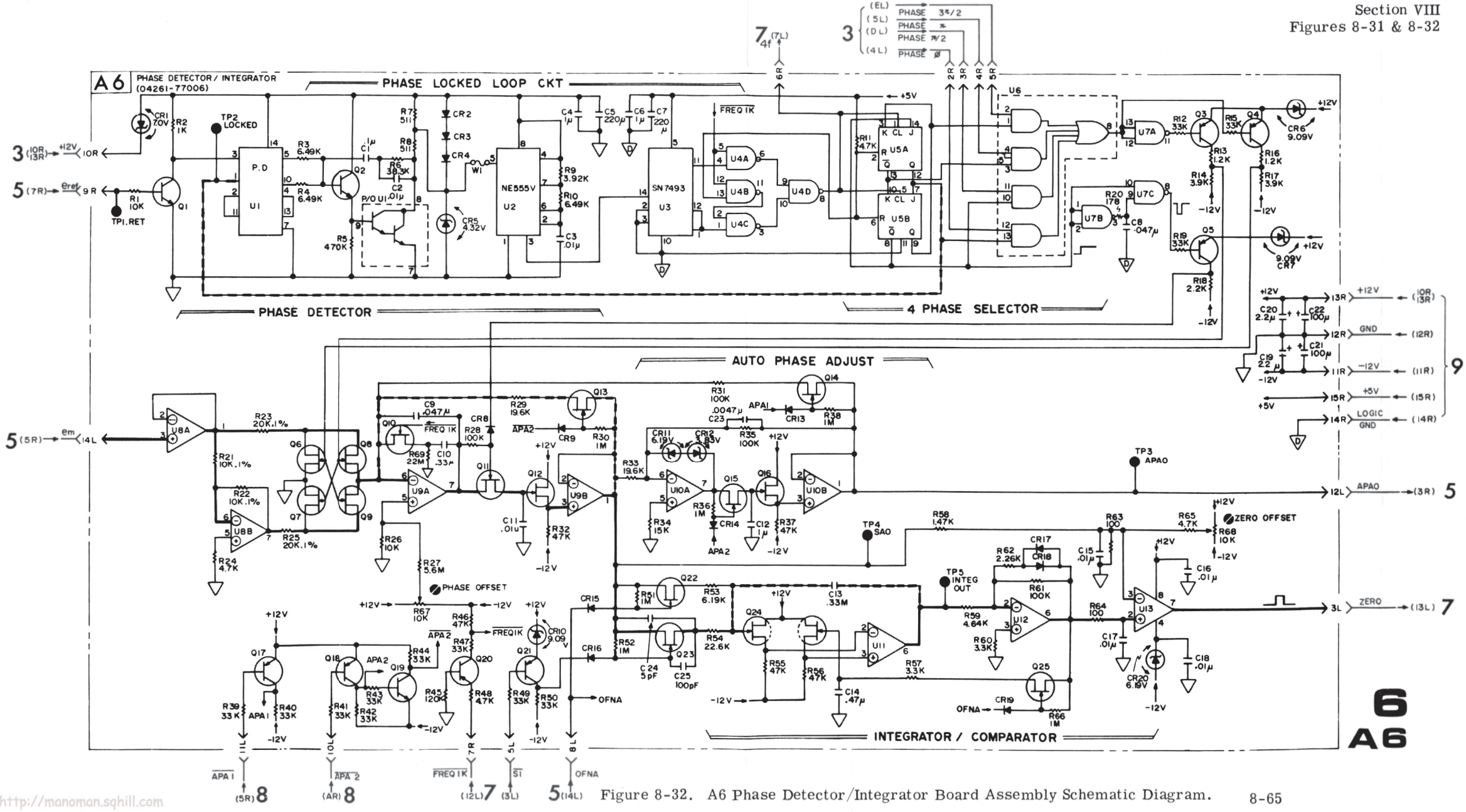

Figure 8-32. A6 Phase Detector/Integrator Board Assembly Schematic Diagram.

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CIRCUIT DESCRIPTION

A7 Board contains Clock Pulse Generator (Y1, U1, U6 thru U8, U14A/B and U15), Data Counter Gate (U9, U15 and U16), Data Counter (U17, U2 thru U5, U20 and U21), Parallel to Serial Converter (U11 and U12) and four Input Multiplexers (U10, U13, U18 and U19).

Clock Pulse Generator. Crystal Y1 and U1 comprise the crystal oscillator whose frequency is 2.5465MHz (TP1). The clock pulse of 31.83kHz at TP4 is generated by dividing 2.5465MHz with U6 and U7. This clock is fed to Data Counter through Data Counter Gate. RSA (at TP5) and RSB (at TP6) signals are outputs of U8 counter and have frequencies of 1.99kHz and 0.99kHz, respectively. These signals are used as the control signals for the Parallel to Serial Converter and sent to A3 board for display control. State clock pulses SCL1 at TP2 and SCL2 at TP3 have a frequency of 127.3kHz with a phase difference of 90° to each other. These signals are used to advance the state of ROM with which they are sychronized.

Data Counter Gate (U9) selects a clock pulse from either of two clocks, the 4f signal (at TP7) or 31.83 kHz (at TP4), as directed by 4fS (4f Select) control signal which is at high level only during L/C measurement and test. For R and D measurements the 31.83kHz clock is selected and fed to Data Counter.

$\overline{SI_2}$ signal is at low level during charging period in L or C measurements, and $\overline{SI_1}$ is low during charging period in R or D measurements and discharge period for all measurements. $\overline{SI}$ signal is at low when either $\overline{SI_1}$ or $\overline{SI_2}$ is at low level.

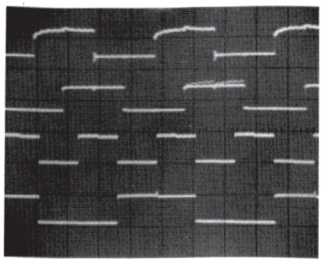
Data Counter is a 3-1/2 digit counter. $\overline{CDC}$ ($\overline{Clear\ Data\ Counter}$) signal resets contents of counter to zero counts. $\overline{SDC}$ ($\overline{Set\ Data\ Counter}$) signal sets counter to 1999 counts. U17, U20 and U21 detects 162 and 1820 counts for autoranging and 80 counts for D measurement.

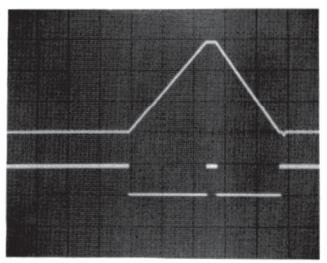
Parallel to Serial Converter U11 and U12 converts parallel BCD data of the counter to serial BCD data with RSA and RSB control signals and its outputs to the A3 board appear as shown in Figure A below.

Input Multiplexer. The four input multiplexers receive various signals: contents of the counter, test frequency, function, range, circuit mode, step, and ZERO, RSA, RSB signals, etc; they each select one of these signals as required and as directed by control signals OPB8 (Output Bit 8) thru OPB10 from A8 board and output the selected signal to A8U1 Multiplexer on A8 Board.

TROUBLESHOOTING INFORMATION

The troubleshooting guide to component level for the A7 board is not given in this service sheet. See Figures 8-11 and 8-12 for A7 troubleshooting.





Measurement conditions:
FUNCTION C
CIRCUIT MODE..... PARA
FREQUENCY 1kHz
Cp TEST SIG LEVEL 1V
Unknown ..... .13μF

Phase Detector/Integrator Board Assembly (A6)
SERVICE SHEET 6

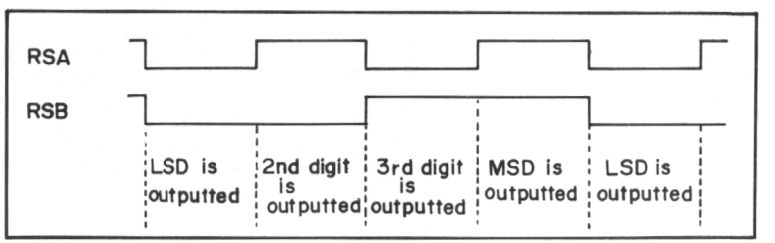


Figure A. Parallel to Serial Conversion.

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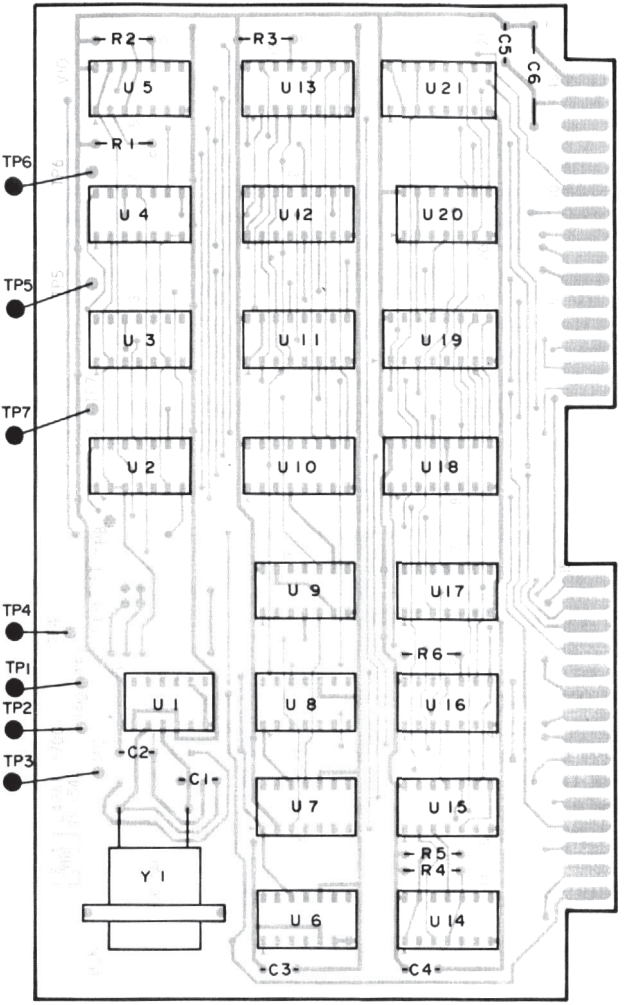

Figure 8-33. A7 Clock Pulse Generator/Counter Board Assembly Component Locations.

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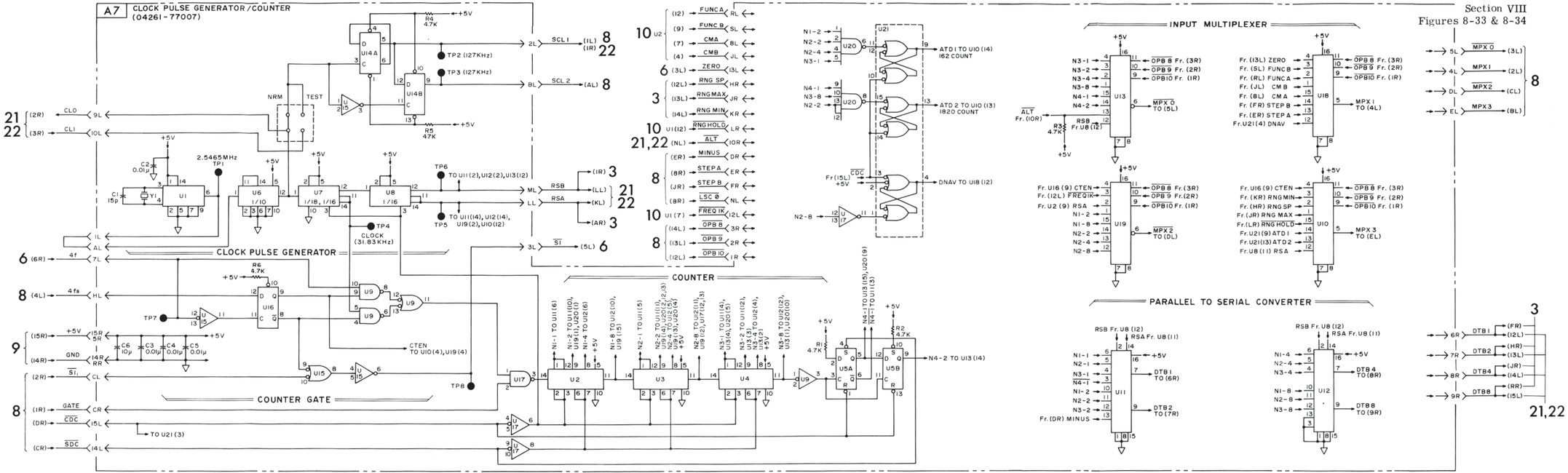

Figure 8-34. A7 Clock Pulse Generator/Counter Board Assembly Schematic Diagram. 8-67

Note

1. Truth table for A7U18 is given below. A7U10 operates the same as A7U18. A7U13 and U19 also operate similar to A7U18 except that the output is the complement of the selected input level.

$\overline{OPB10}$ (9)	$\overline{OPB9}$ (10)	$\overline{OPB8}$ (11)	MPX1 (5)
L	L	L	ZERO
L	L	H	FUNC B
L	H	L	FUNC A
L	H	H	CMB
H	L	L	CMA
H	L	H	STEP B
H	H	L	STEP A
H	H	H	DNAV

H: high level
L: low level

2. Truth table for A7U11 is given below. A7U12 operates the same as A7U11.

RSB (2)	RSA (14)	DTB 1 (7)	DTB 2 (9)
L	L	N1 - 1	N1 - 2
L	H	N2 - 1	N2 - 2
H	L	N3 - 1	N3 - 2
H	H	$\overline{N4 - 1}$	MINUS

H: high level
L: low level

3. A7S1 should be set to NRM position.

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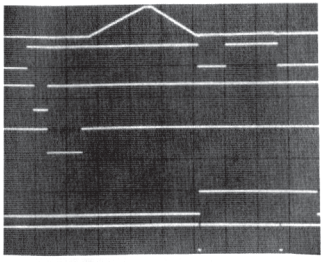
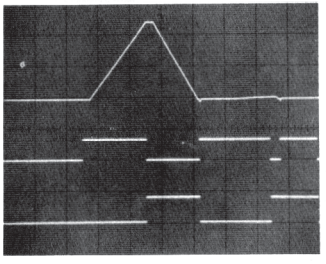


Measurement conditions:
FUNCTION C
CIRCUIT MODE ..... PARA
FREQUENCY 1kHz
Cp TEST SIG LEVEL 1V
Unknown ..... .13μF



Measurement conditions:
FUNCTION C
CIRCUIT MODE ..... PARA
FREQUENCY 1kHz
Cp TEST SIG LEVEL 1V
Unknown ..... .13μF

CIRCUIT DESCRIPTION

The A8 Measurement Sequence Control board is the heart of the 4261A Digital Section and manages various Analog Section operations including the autoranging. This control board includes the Multiplexers, State Counter/Register, ROM, Step Counter, Decoders and Range/Step Selector. The Input Multiplexers (U12, U6) receive CMS, MS (Measurement Status), SAT (Saturation), and remove control signals, etc., and select one signal from among them as directed by control signals $\overline{\text{OPB8}}$ (output Bit 8) thru $\overline{\text{OPB10}}$ and output selected signal as MPX4 and $\overline{\text{MPX5}}$. Multiplexer U1 receives outputs from six input multiplexers (two on A8 board and four on A7 board) and selects one signal as directed by control signals OPB11 thru OPB13. The output of Multiplexer U1 is fed through U14 to U13 where it is sychronized with SCL2 (State Clock 2). Qualifier signal at TP1 is an output of U13 and is sent to State Counter/Register (U2, U7) which works as a latch for OPB0 thru OPB7 signals when the qualifier signal is at low level, or as a counter for SCL1 signal when qualifier is at high level. The outputs for State Counter/Register are fed to ROM U8 which outputs OPB0 thru OPB15 signals. Signals OPB0 thru OPB7 are fed back to State Counter Register to determine the next state of the ROM. Signals OPB8 thru OPB10 are sent to Input Multiplexers to select one signal and also sent to Decoders U5, U10 and U17 to output various instructions to Analog Section, Multiplexers and other circuits.

When the $\overline{\text{LSC0}}$ signal is at low level, the U16 Presetable Up/down Counter receives range control signals ($\overline{\text{RNG UP}}$ and $\overline{\text{RNG DWN}}$ when RANGE HOLD is set to OFF), takes a counts, and outputs the counts as RNG A, RNG B and RNG C signals which are, in turn, selected by U15 selector and fed to A3 board as SLO1 thru SLO4 signals.

When $\overline{\text{LSC0}}$ signal is high, U15 selects STEP A, STEP B, MS and $\overline{\text{TEST2}}$ signals and outputs them as SLO1 thru SLO4. U18 is a step counter, whose input signal is $\overline{\text{ISC}}$ (Increment Step Counter), assigns the measurement step. U13 and U11 form a trigger lamp driver. The Turn On Trigger Generator consists of U19, U3, Q1 and Q2. It outputs a turn-on-trigger signal only when LINE switch is turned to ON.

TROUBLESHOOTING INFORMATION

See Figures 8-11 and 8-12 for A8 troubleshooting to the component level as an A8 troubleshooting guide is not provided in this service sheet.

Clock Pulse Generator/Counter Board Assembly (A7)
SERVICE SHEET 7

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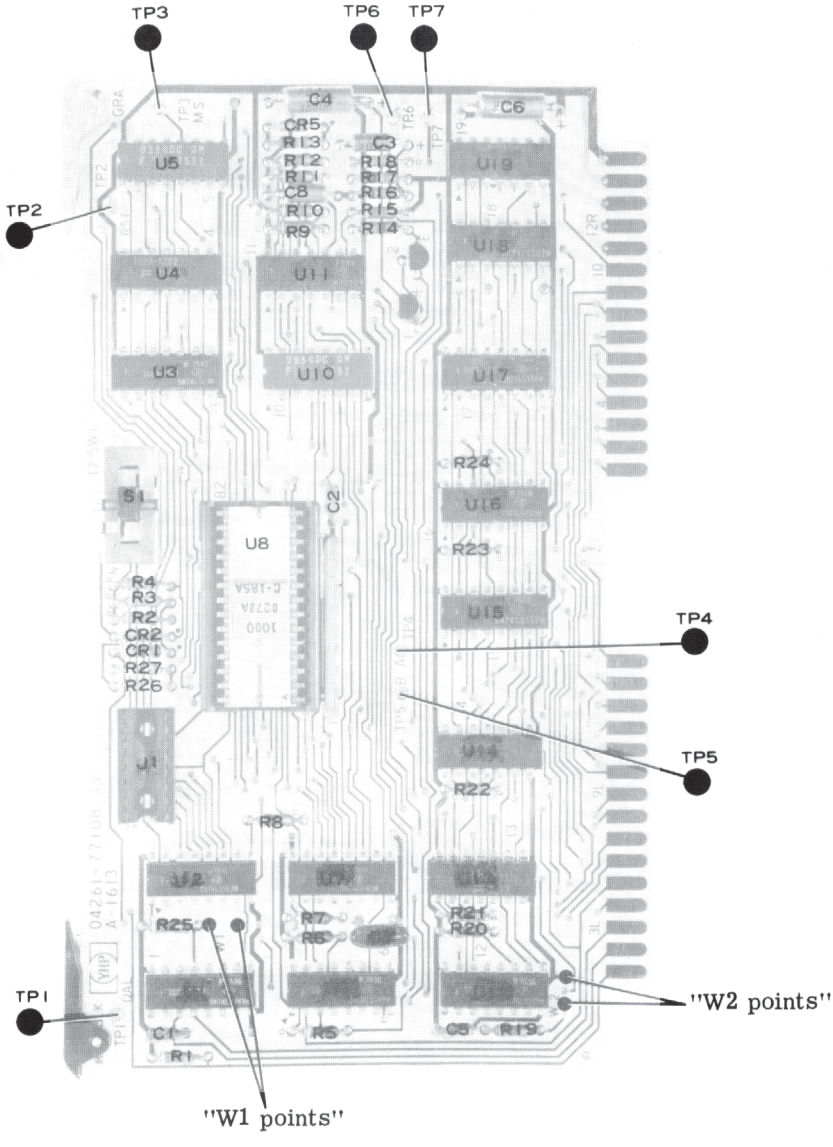

Figure 8-35. A8 Sequence Control Board Assembly Component Locations.

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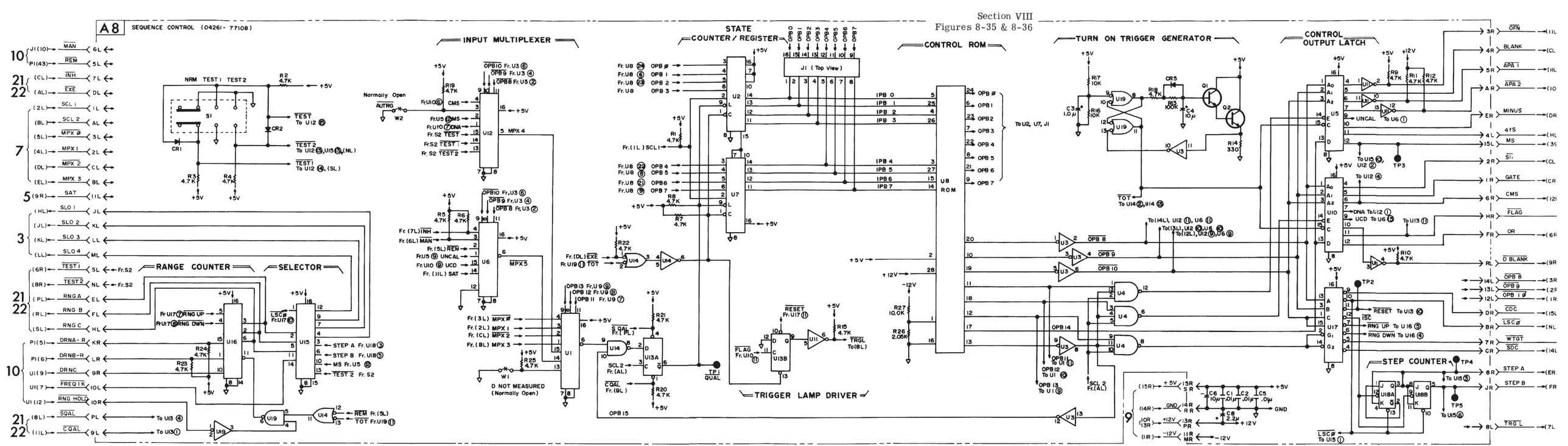

Figure 8-36. A8 Sequence Control Board Assembly Schematic Diagram. 8-69 **A8 8**

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Note

1. Truth table for A8U1, U6 and U12. See note 1 on A7 board circuit schematic.

2. See Section III paragraph 3-48 for "how to use A8W1 and W2 jumper wire connections".

3. Truth table for A8U15:

$\overline{\text{LSC 0}}$ (1)	SLO 1 (4)	SLO 2 (7)	SLO 3 (9)	SLO 4 (12)
L	RNG A	RNG B	RNG C	$\overline{\text{FREQ 1k}}$
H	STEP A	STEP B	MS	$\overline{\text{TEST 2}}$

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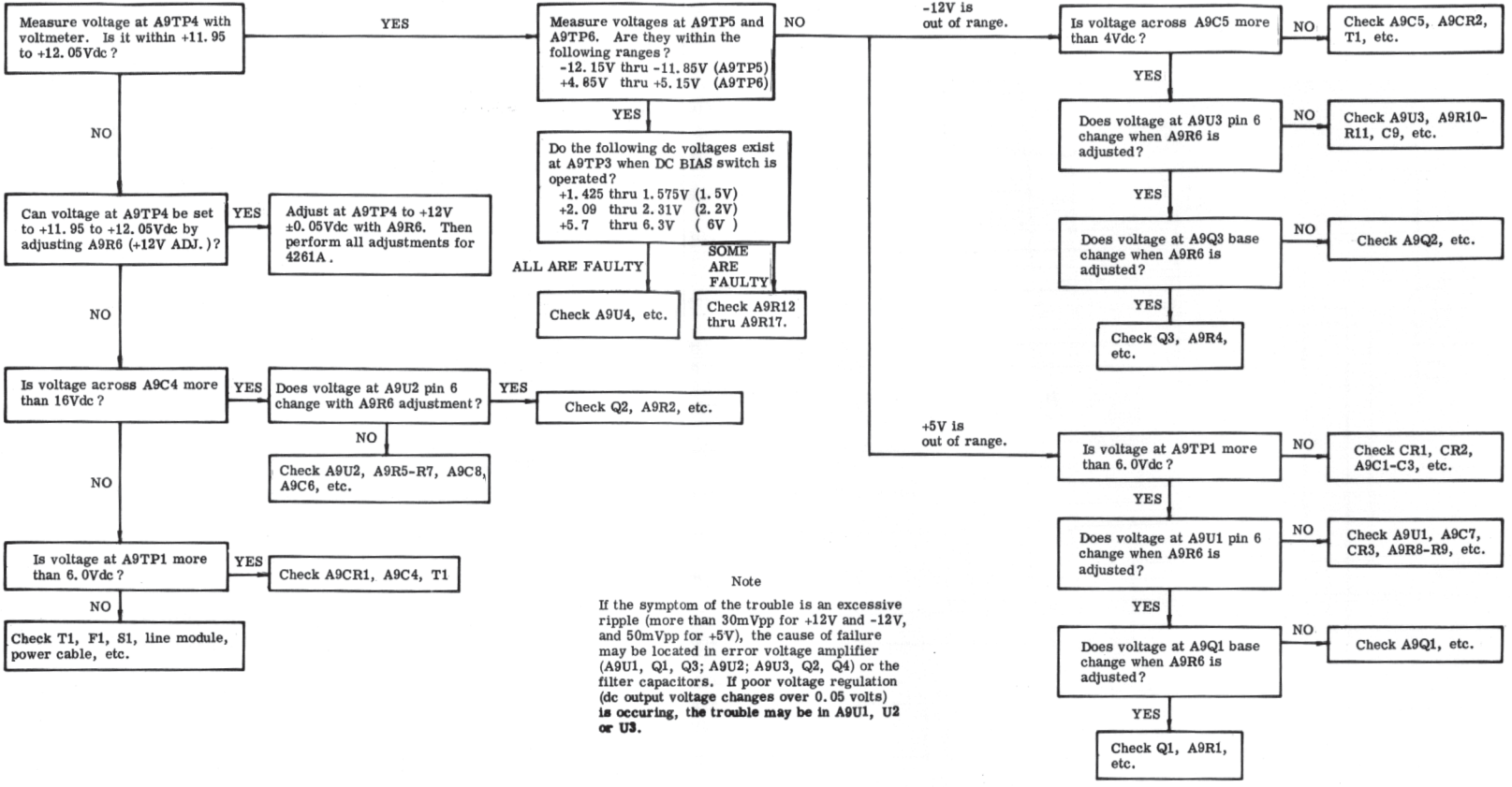

Figure 8-37. DC Power Supply Section Troubleshooting Guide.

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CIRCUIT DESCRIPTION

AC line power is inputted to power transformer T1 through the power cable and a line module which houses a built-in filter and a line voltage selection card. A fuse (F1), of proper rating, is inserted in the line module. The three ac outputs from T1 are rectified and stabilized to dc voltages by their respective regulator circuits. Regulator transistor Q1 is mounted on the rear panel and diodes CR1 thru CR3 and transistors Q2 and Q3 are mounted directly on the instrument rear deck for best thermal radiation. A 5V dc voltage is developed by the circuitry consisting of CR1, CR2, Q1, A9Q1, A9U1, etc. A9R5 is a sensor resistor for over current protection and CR3 is an over voltage protection zener diode. The +12Vdc is generated by circuitry which includes A9CR1, Q2, A9U2, etc. and the -12Vdc by Q3, A9CR2, A9Q2 and Q3, A9U3, etc. Output dc voltages can be adjusted by A9R8 which sets the +12V to its exact operating voltage along with the +5V and -12V supplies. Note that exact +5V and -12V voltages depend directly on an exact setting of the +12V. A9U4 and associated resistors provide the internal dc bias source for +1.5V, 2.2V and 6V. The reference voltage for the bias source is the regulated +12V and divider.

TROUBLESHOOTING INFORMATION

The troubleshooting tree (guide) for the power supply section is presented at the left.

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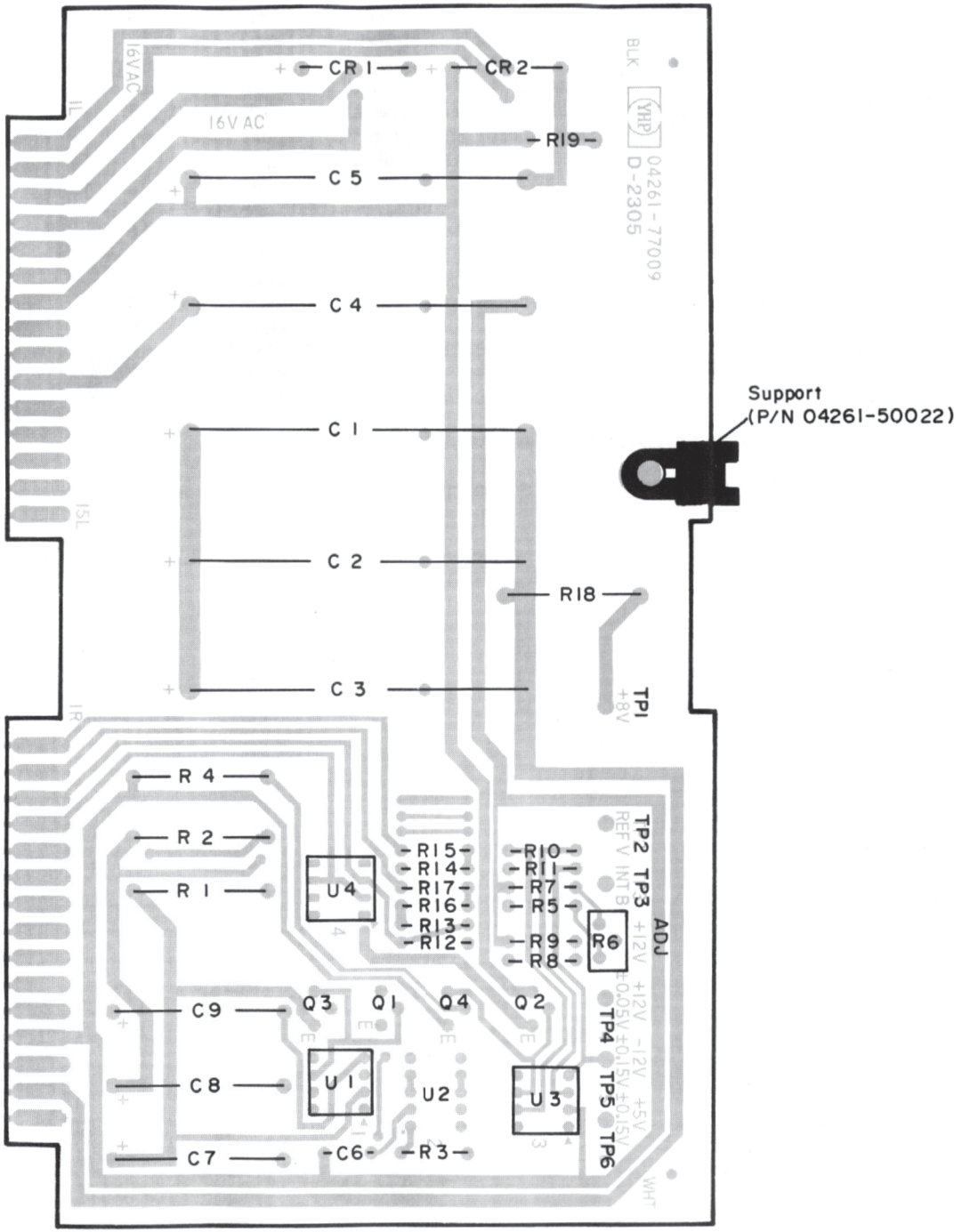

Figure 8-38. A9 Power Supply Board Assembly Component Locations.

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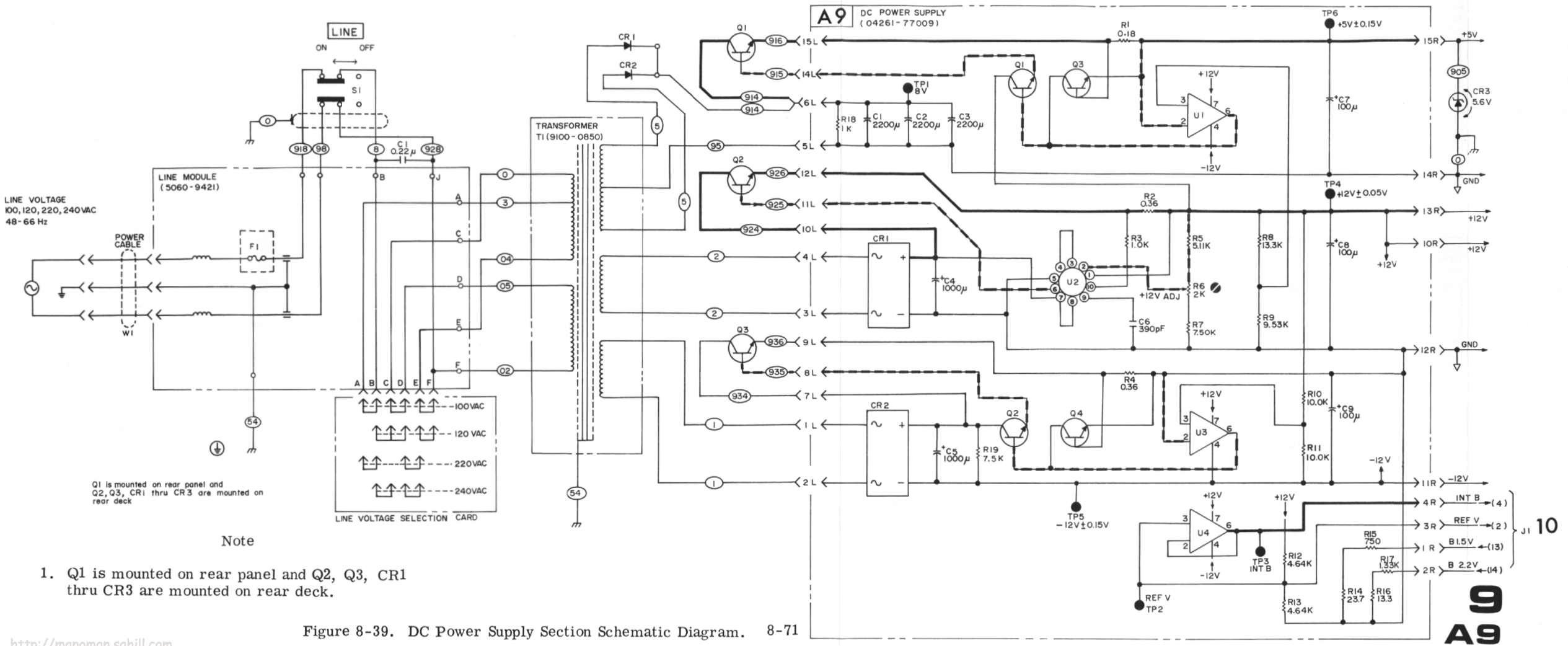

Note

1. Q1 is mounted on rear panel and Q2, Q3, CR1 thru CR3 are mounted on rear deck.

Figure 8-39. DC Power Supply Section Schematic Diagram. 8-71

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A9

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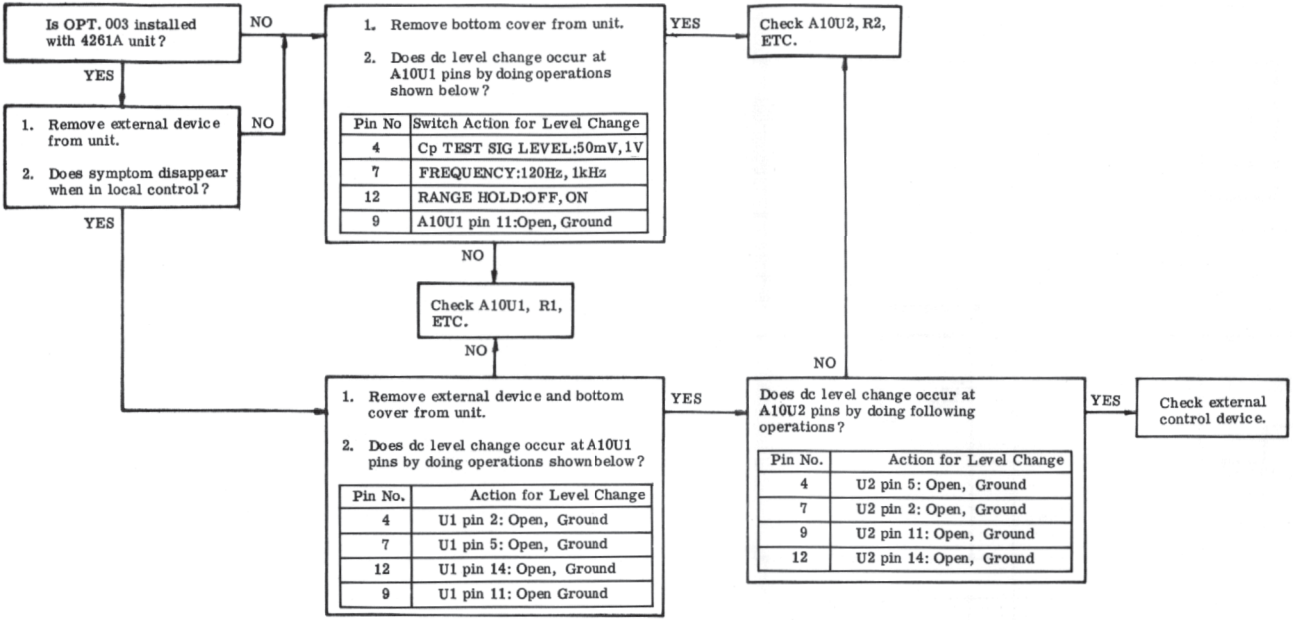

Figure 8-40. A10 Motherboard Troubleshooting Guide.

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CIRCUIT DESCRIPTION

The A10 Mother board assembly is the interconnection between nearly all other board assemblies. All these interconnections are not shown in the circuit schematics for the A10 board. For A10 board troubleshooting, only the main connections are presented. The A10 Mother board includes a selector circuit for selecting either remote control or local control signals. Remote control signals are sent through the remote control plug of the A10 board from the rear panel remote input connector (OPT. 003), and local signals are transferred via a flat cable from the A1 switch board (front panel control). The selector (A10U1 & U2) outputs local control signals when pin 1 of both A10U1 and U2 ($\overline{\text{REM}}$ signal) are at high level, and outputs remote control signals when the $\overline{\text{REM}}$ signal is at low level. Two signals, DRNG A, DRNG B, are sent to 4261A internal circuit without going through the A10 selector. The A10 board plug not only receives the remote control signals, but also outputs the various signals shown in right bottom section of the circuit schematic and are utilized for automatic test in the factory. The lead wires from the UNKNOWN terminals are soldered directly to the A10 board. Wired connections for rear connectors such as EXT BIAS and C OFFSET are made on the A10 board.

TROUBLESHOOTING INFORMATION

The A10 board troubleshooting guide is presented at the left.

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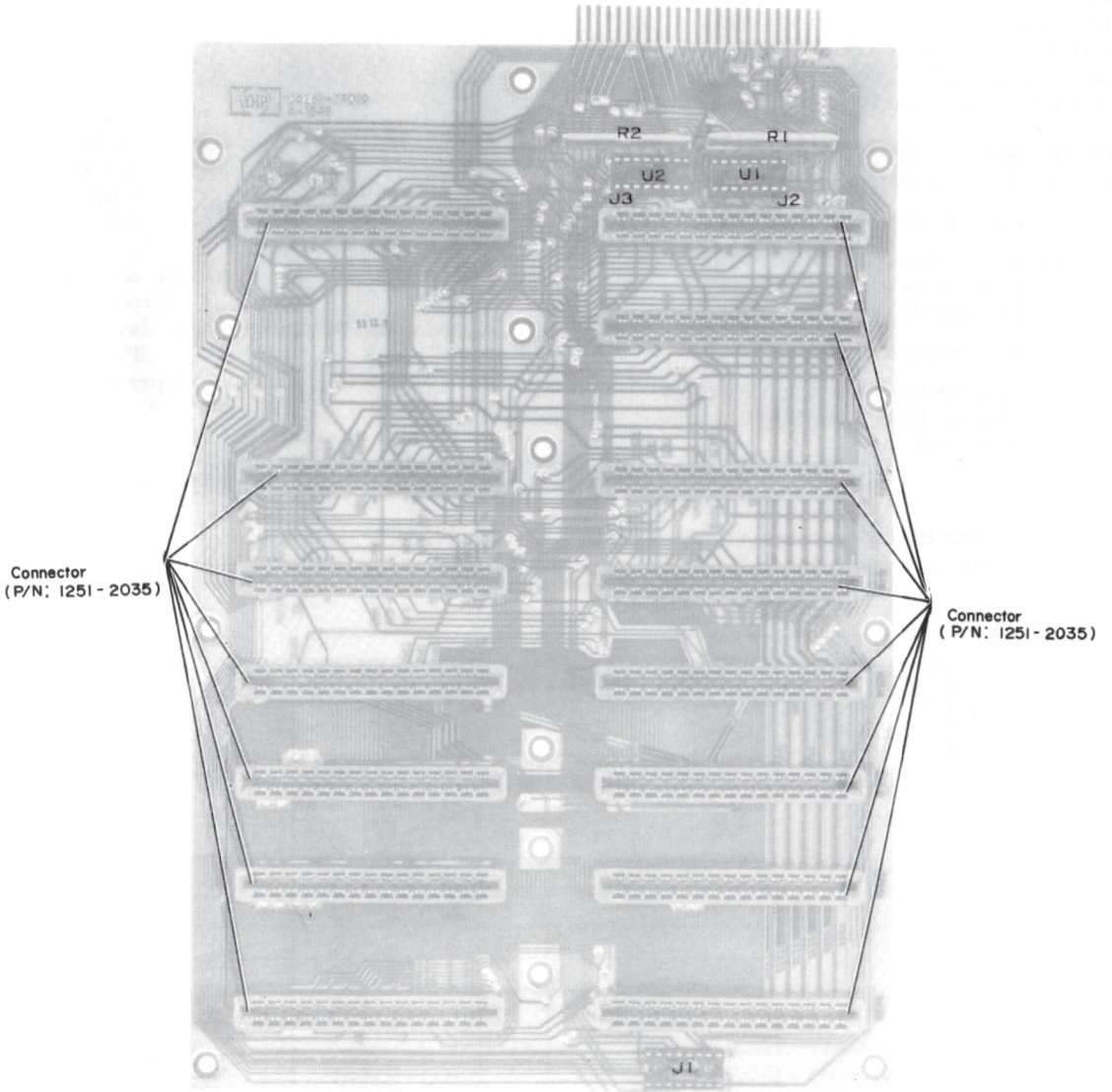

Figure 8-41. A10 Motherboard Assembly Component Locations.

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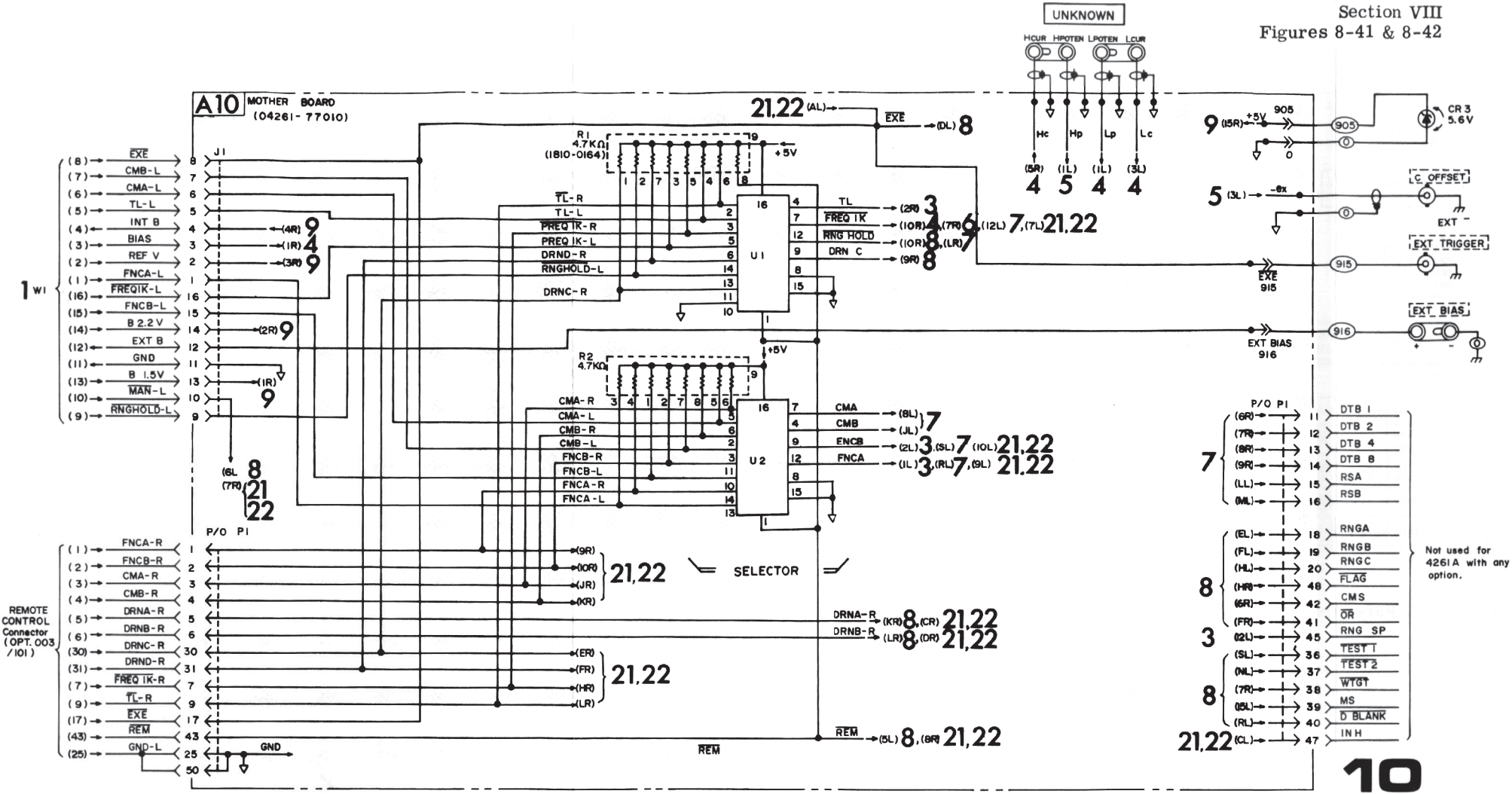

Figure 8-42. A10 Mother Board Assembly Schematic Diagram.

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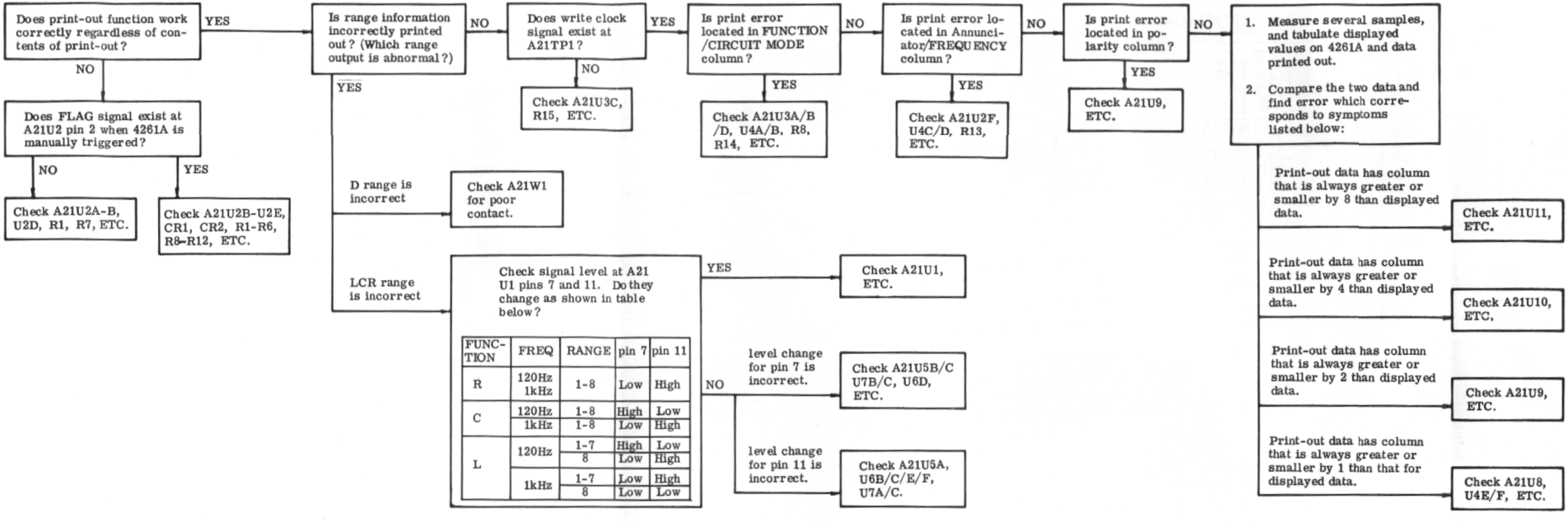

FUNC-TION	FREQ	RANGE	pin 7	pin 11
R	120Hz 1kHz	1-8	Low	High
C	120Hz	1-8	High	Low
	1kHz	1-8	Low	High
L	120Hz	1-7	High	Low
		8	Low	High
	1kHz	1-7	Low	High
		8	Low	Low

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Figure 8-43. A21 Parallel BCD Data Output Board (OPT. 001) Troubleshooting Guide.

Table A. Output Data Format (Cont'd).

DATA OUTPUT (Column No.)	4261A Display/Setting		Pin No. 15	16	40	41*	Character Printed
Annunciation & Test Frequency (8)	No Annunciation	120Hz	L	L	L	L	0
		1kHz	L	L	H	L	4
	OUT OF RANGE	120Hz	H	L	L	L	1
		1kHz	H	L	H	L	5
	D Unavailable	120Hz	L	H	L	L	2
		1kHz	L	H	H	L	6
	OUT OF RANGE D Unavailable	120Hz	H	H	L	L	3
		1kHz	H	H	H	L	7

DATA OUTPUT (Column No.)	4261A Full Scale Display L	C	R	Pin No. 17	18	42	43	Character Printed
Range (9)	100.0μH	100.0pF	1000mΩ	H	L	L	L	1
	1000μH	1000pF	10.00Ω	L	H	L	L	2
	10.00mH	10.00nF	100.0Ω	H	H	L	L	3
	100.0mH	100.0nF	1000Ω	L	L	H	L	4
	1000mH	1000nF	10.00kΩ	H	L	H	L	5
	10.00H	10.00μF	100.0kΩ	L	H	H	L	6
	100.0H	100.0μF	1000kΩ	H	H	H	L	7
	1000H	1000μF	10.00MΩ	L	L	L	H	8
		10.00mF		H	L	L	H	9
	D: 1.000			L	L	L	L	0

DATA OUTPUT (Column No.)	4261A Display L	C	R	Pin No. 19	20	44	45*	Character Printed
Function & Circuit Mode (10)	PARA(Lp)			L	H	L	L	2
	SER (Ls)			H	H	L	L	3
		PARA(Cp)		L	L	L	L	0
		SER (Cs)		H	L	L	L	1
			PARA(Rp)	L	L	H	L	4
			SER (Rs)	H	L	H	L	5

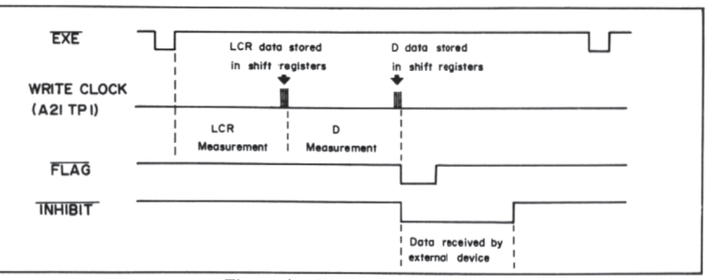

Figure A. Timing Diagram.

Motherboard Assembly (A10)
SERVICE SHEET 10

CIRCUIT DESCRIPTION

The A21 Board Assembly receives the measured data, range, function, circuit mode, annunciation and frequency signals from the standard 4261A unit and outputs them to an external device through rear panel connectors. The transfer of these signals is managed by control signals $\overline{\text{FLAG}}$, $\overline{\text{INHIBIT}}$ and $\overline{\text{EXE}}$. A range decoder outputs range signals (RANGE 1, RANGE 2, RANGE 4 and RANGE 8) in BCD form. The range decoder includes A21U1 (full adder) that sums range signals RNG A, RNG B and RANGE C (A8 Range Counter output), and B1 and B2 signals. B1 and B2 signals are developed by A21 U5, U6 and U7 gates in the following manner:

B1 is High and B2 is Low when either of the following measurements - are being made:

- —— a C measurement at 1kHz, or
- —— an L measurement at 1kHz and when at least one of either RNG A, RNG B and RNG C is at low level, or
- —— an R measurement, or
- —— an L measurement at 120Hz and when RNG A, RNG B and RNG C are all at high level.

B2 is High and B1 is low when either of these measurements are being made:

- —— a C measurement at 120Hz, or
- —— an L measurement at 120Hz and when at least one of either RNG A, RNG B and RNG C is at low level.

Both B1 and B2 are low when these measurements are being made:

- —— an L measurement at 1kHz and RNG A, RNG B and RNG C are all at high level.

Both B1 and B2 at high level never occurs.

Function, circuit mode, frequency, annunciation and FLAG signal are transferred to the external device, and EXE and INHIBIT signals are transferred to the 4261A via buffer gates on this board. A21U8 thru U11 integrated circuits are shift registers which input serial data signals (DTB1, DTB2, DTB4, DTB8) from A7 board synchronized with WRITE CLOCK signal at A21TP1 and which output the data in a parallel scheme to an external device after the $\overline{\text{FLAG}}$ signal goes to low level. The fundamental data transfer timing diagram is presented at the left. A table showing digital signals at each pin of the output connectors is included.

TROUBLESHOOTING INFORMATION

The troubleshooting tree (guide) for A21 board is presented at the left.

Table A. Output Data Format.

DATA OUTPUT (Column No.)	4261A Display	Digit	Pin No. 1	2	26	27	Character Printed
		10^0	1	2	26	27	
		10^1	3	4	28	29	
		10^2	5	6	30	31	
		10^3	7	8*	32*	33*	
Displayed L/C/R/D Value (1 thru 4)	0		L	L	L	L	0
	1		H	L	L	L	1
	2		L	H	L	L	2
	3		H	H	L	L	3
	4		L	L	H	L	4
	5		H	L	H	L	5
	6		L	H	H	L	6
	7		H	H	H	L	7
	8		L	L	L	H	8
	9		H	L	L	H	9

DATA OUTPUT (Column No.)	4261A Display	Pin No. 13	14*	38*	39*	Character Printed
Polarity (7)	+ (Blanked)	L	H	L	H	+
	-	H	H	L	H	-

* These pins are grounded except for pins 14 and 39 which are pulled up to +5V.

Note: L: TTL Low Level.
H: TTL High Level.

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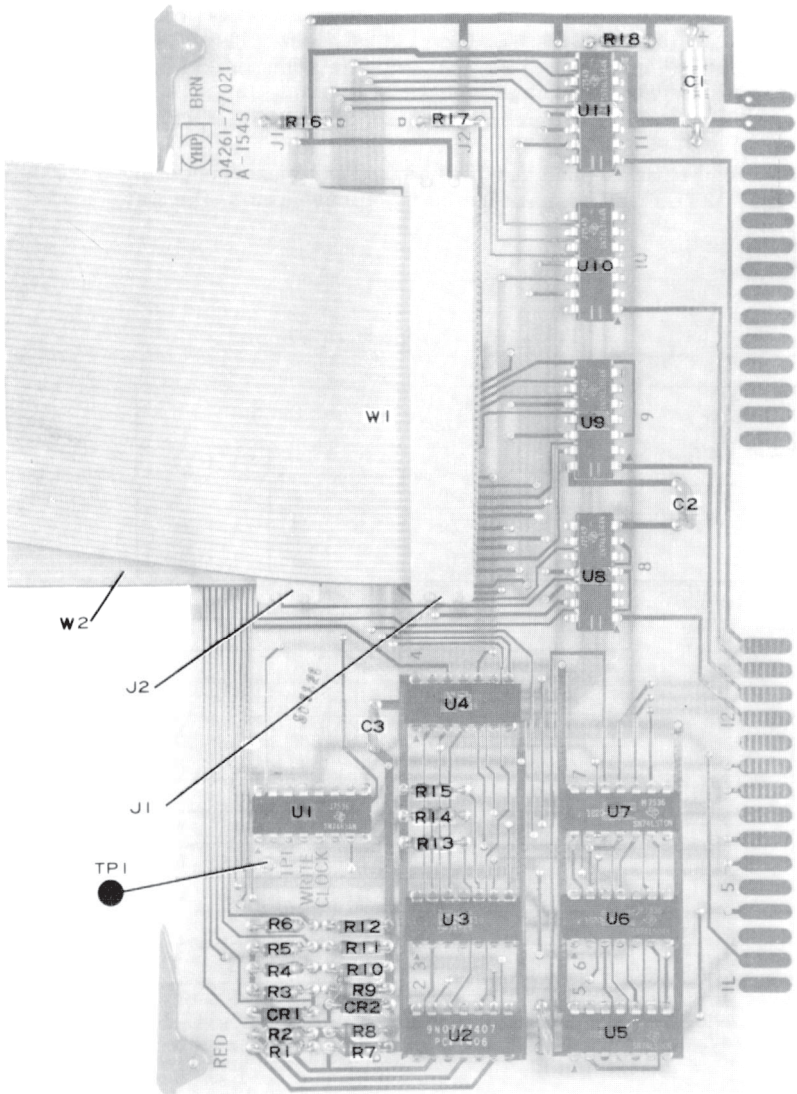

Figure 8-44. A21 Parallel BCD Data Output Board Assembly Component Locations.

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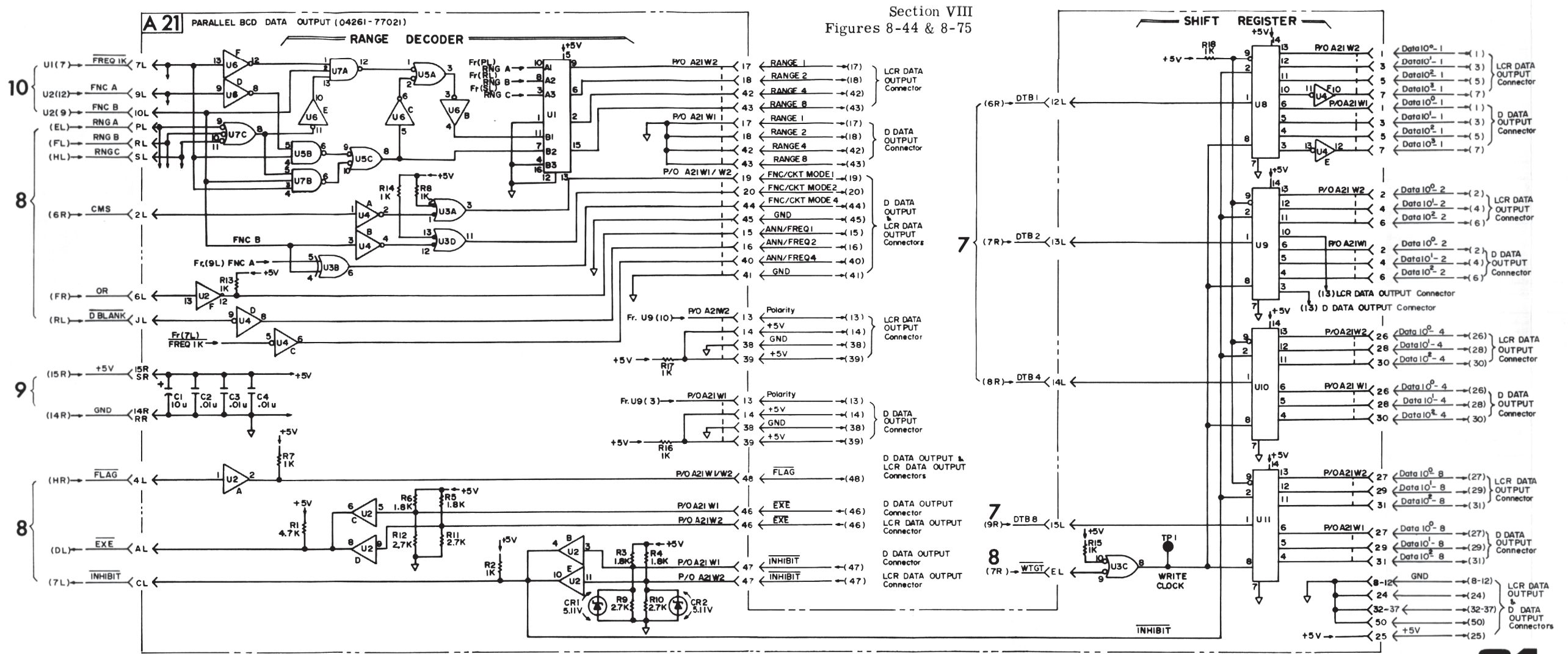

Figure 8-45. A21 Parallel BCD Data Output Board Assembly (OPT. 001) Schematic Diagram. 8-75

A21 21

Note

1. A21U1, 4bit binary full adder, works as follows:

$$E1 + 2^1E2 + 2^2 \cdot E3 + 2^3 \cdot E4 = (A1 + 2^1 \cdot A2 + 2^2 \cdot A3) + (B1 + 2^1 \cdot B2 + 2^2 \cdot B3)$$

E: output; A, B: input

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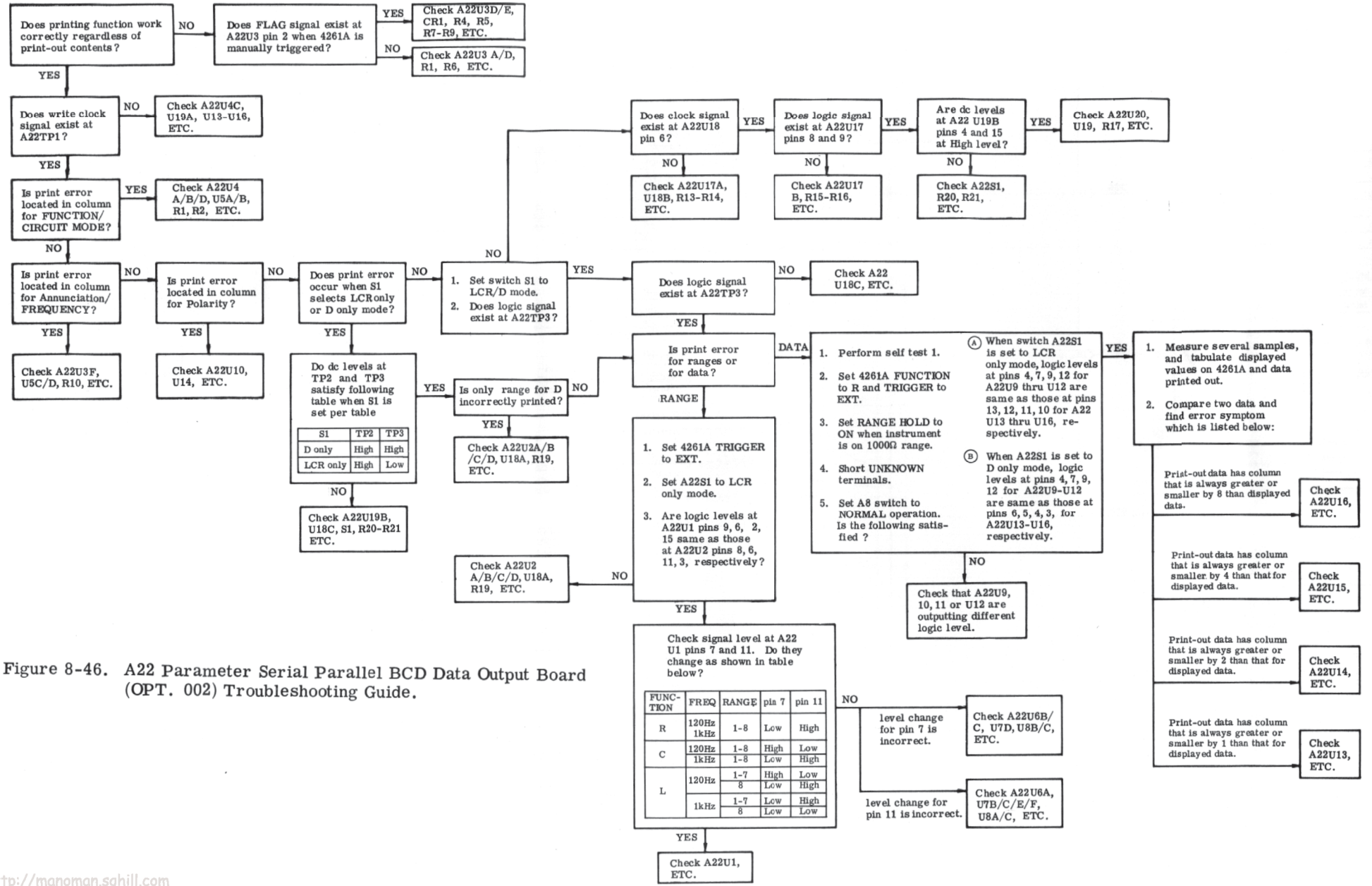

Figure 8-46. A22 Parameter Serial Parallel BCD Data Output Board (OPT. 002) Troubleshooting Guide.

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Table A. Output Data Format (Cont'd).

DATA OUTPUT (Column No.)	4261A Display/Setting		Pin No. 15	16	40	41*	Character Printed
Annunciation & Test Frequency (8)	No Annunciation	120Hz	L	L	L	L	0
		1kHz	L	L	H	L	4
	OUT OF RANGE	120Hz	H	L	L	L	1
		1kHz	H	L	H	L	5
	D Unavailable	120Hz	L	H	L	L	2
		1kHz	L	H	H	L	6
	OUT OF RANGE D Unavailable	120Hz	H	H	L	L	3
		1kHz	H	H	H	L	7

DATA OUTPUT (Column No.)	4261A Full Scale Display L	C	R	Pin No. 17	18	42	43	Character Printed
Range (9)	100.0μH	100.0pF	1000mΩ	H	L	L	L	1
	1000μH	1000pF	10.00Ω	L	H	L	L	2
	10.00mH	10.00nF	100.0Ω	H	H	L	L	3
	100.0mH	100.0nF	1000Ω	L	L	H	L	4
	1000mH	1000nF	10.00kΩ	H	L	H	L	5
	10.00H	10.00μF	100.0kΩ	L	H	H	L	6
	100.0H	100.0μF	1000kΩ	H	H	H	L	7
	1000H	1000μF	10.00MΩ	L	L	L	H	8
		10.00mF		H	L	L	H	9
	D: 1.000			L	L	L	L	0

DATA OUTPUT (Column No.)	4261A Display L	C	R	Pin No. 19	20	44	45*	Character Printed
Function & Circuit Mode (10)	PARA(Lp)			L	H	L	L	2
	SER (Ls)			H	H	L	L	3
		PARA(Cp)		L	L	L	L	0
		SER (Cs)		H	L	L	L	1
			PARA(Rp)	L	L	H	L	4
			SER (Rs)	H	L	H	L	5

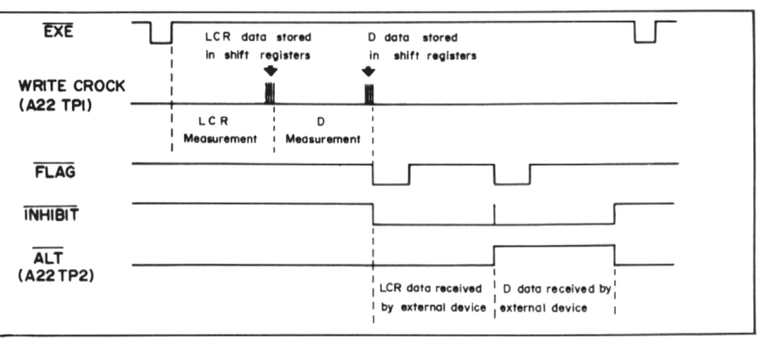

Figure A. Timing Diagram.

Parallel BCD Data Output Board Assembly (A21)
SERVICE SHEET 21

CIRCUIT DESCRIPTION

The A22 board assembly receives measured data, range, function, circuit mode, annunciation and frequency signals from the standard unit and outputs them to an external device through rear panel connectors. LCR and D data are serially transferred. A22S1 can select the output data as: LCR data only, LCR and D data, or D data only. The range decoder (A21U6, U7, U8, U1, U2) section works in the same manner as the range decoder on the A21 board (see service sheet No. 21) except that the outputted range signals (RANGE 1, RANGE 2, RANGE 4 and RANGE 8) are set to zero (low level) by being gated at A22U2 with the signal from A22TP3. The Data Selection Control section manages the selection of outputted data (LCR data or D data) and sends the D range signal to A22U18 and U2. The input signals for this section are $\overline{\text{INHIBIT}}$, SCL 1, $\overline{\text{WTGT}}$ and signals from S1. SCL 1 signal is used as a clock for advancing the function of this section similar to that of a state machine. The $\overline{\text{WTGT}}$ signal initially resets the level at A22TP3 to low level. The logic level at TP3 is changed by the trailing edge of the $\overline{\text{INHIBIT}}$ signal. Shift registers A22U13 thru U16 store the measured data (LCR and D) from the A7 board and are synchronized with the WRITE CLOCK signal at A22TP1. A22U9 thru U12 are selectors which select LCR data when the voltage level at A22TP3 is low, and D data when TP3 is high. The following diagram shows the fundamental timing of data transfer. Digital signals at each pin of the output connector are included in the associated table below:

TROUBLESHOOTING INFORMATION

The troubleshooting tree (guide) for A22 board in presented at the left.

Table A. Output Data Format.

DATA OUTPUT (Column No.)	4261A Display Digit	Pin No.				Character Printed
	10^0	1	2	26	27	
	10^1	3	4	28	29	
	10^2	5	6	30	31	
	10^3	7	8*	32*	33*	
Displayed L/C/R/D Value (1 thru 4)	0	L	L	L	L	0
	1	H	L	L	L	1
	2	L	H	L	L	2
	3	H	H	L	L	3
	4	L	L	H	L	4
	5	H	L	H	L	5
	6	L	H	H	L	6
	7	H	H	H	L	7
	8	L	L	L	H	8
	9	H	L	L	H	9

DATA OUTPUT (Column No.)	4261A Display	Pin No. 13	14*	38*	39*	Character Printed
Polarity (7)	+ (Blanked)	L	H	L	H	+
	-	H	H	L	H	-

* These pins are grounded except for pins 14 and 39 which are pulled up to +5V.

Note: L: TTL Low Level.
H: TTL High Level.

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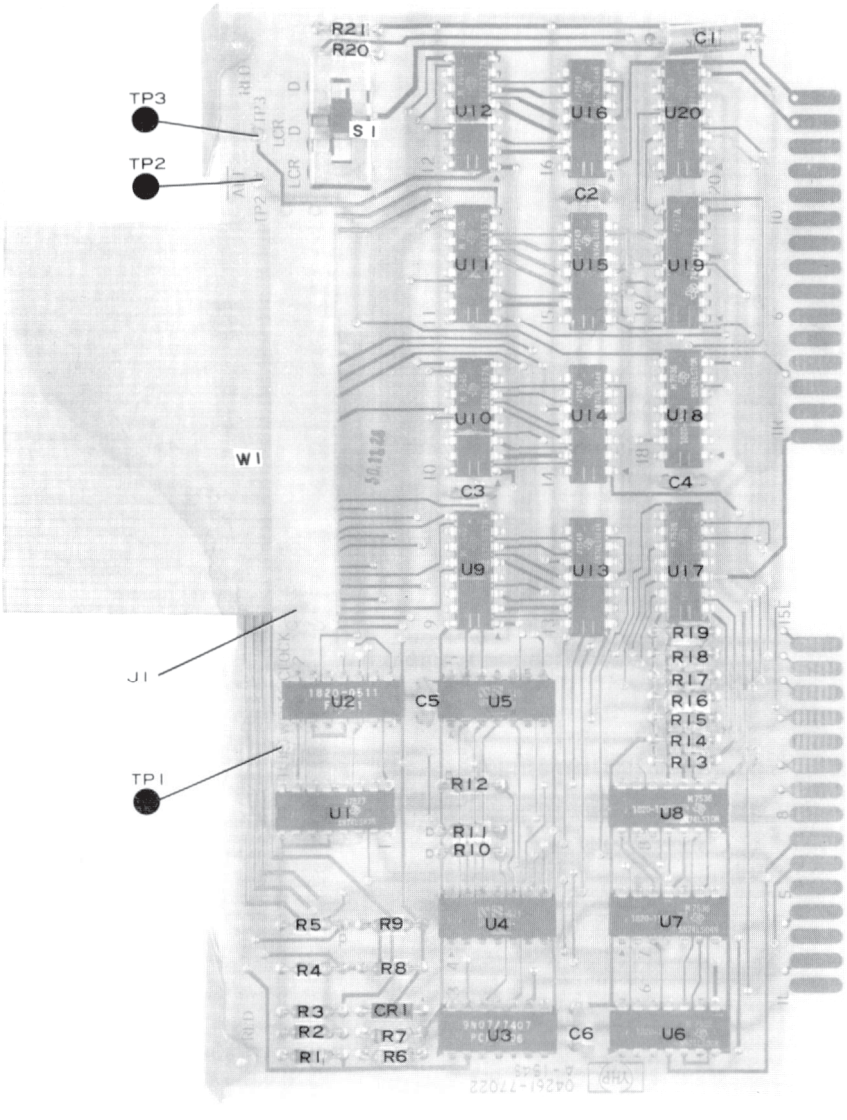

Figure 8-47. A22 Parameter Serial Parallel BCD Data Output Board Assembly Component Locations.

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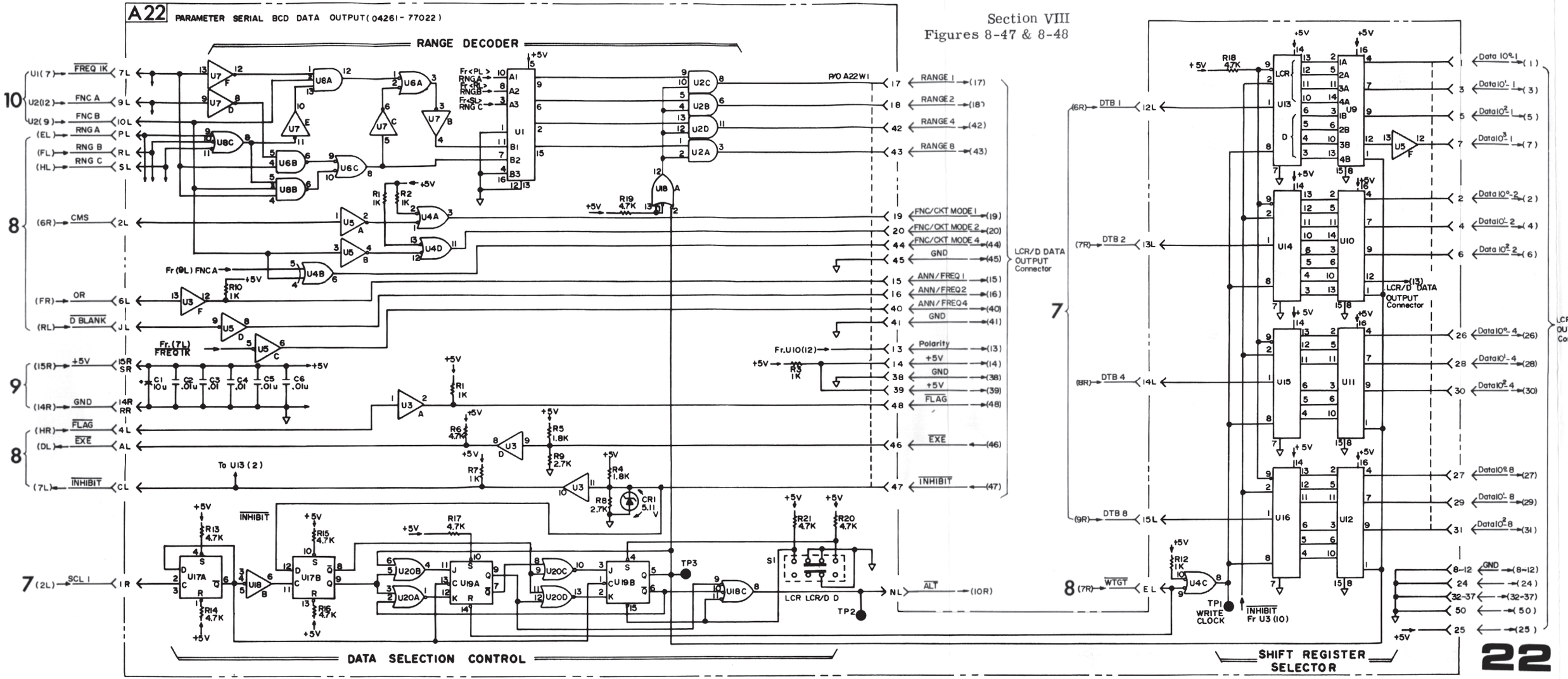

Figure 8-48. A22 Parameter Serial Parallel BCD Data Output Board Assembly (OPT. 002) Schematic Diagram. 8-77

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